

**COCONA, INC. v. VF OUTDOOR, LLC**

**CASE NO. 1:16-CV-2703 CMA**

**INFRINGEMENT CLAIM CHART FOR U.S. PATENT NO. 8,945,287 B2**

<b>CLAIM No.</b>	<b>‘287 CLAIM LANGUAGE</b>	<b>INFRINGING PRODUCTS</b>
		<p>Cocona, Inc. (“Cocona”) presently contends that the Infringing Products<sup>1</sup> are marketed and sold by VF Outdoor, LLC (“VF Outdoor”) under The North Face (“TNF”) brand. The Infringing Products literally infringe at least the claims of U.S. Patent No. 8,945,287 B2 (the “‘287 Patent”) asserted herein. Nevertheless, with respect to any claim limitation that may be found not to be literally infringed, Cocona contends in the alternative that the Infringing Products infringe such claim limitations under the doctrine of equivalents and that any element not found to be literally met is equivalently met because any difference between the claim limitation and the Infringing Product is not a substantial difference. Accordingly, Cocona contends that any asserted claim that the Infringing Products are not found to infringe literally is nevertheless embodied by the Infringing Products under the doctrine of equivalents under an operative doctrine of equivalents test (<i>e.g.</i> insubstantial differences).</p> <p>To the extent that a third party performs or contributes to infringement of any asserted claim, Cocona contends that all asserted claims are infringed by VF Outdoor under traditional theories of joint and several liability in the context of tort law.</p> <p>Cocona contends that VF Outdoor infringes Claims 27, 35, 36, and 37<sup>2</sup> by making, selling, and offering to sell clothing products that incorporate a fabric with a 2.5 layer construction marketed by VF Outdoor and/or TNF under the name DryVent™ 2.5L (each an “Infringing Product” as more specifically set forth in Ex. A). DryVent™ 2.5L fabrics are</p>

<sup>1</sup> Cocona identifies each of the Infringing Products in Ex. A.

<sup>2</sup> Cocona expressly reserves the right to assert additional claims of the ‘287 Patent in the future based on information learned during discovery and/or following the issuance of a claim construction Order.

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		<p>primarily used for highly active, fast and light pursuits, where light weight and packable is an essential requirement of the user. The inner layer of the DryVent™ 2.5L fabric is finished with a functional dry touch print that helps raise the fabric from the skin to provide comfort and enable the quick transfer of vapor through to the outside of the fabric. All DryVent™ fabrics, including DryVent™ 2.5L, are engineered to be fully waterproof, windproof and breathable. The outer face of each DryVent™ fabric, including DryVent™ 2.5L, is treated with a durable water repellant finish that helps form droplets and repel water from the surface. Each DryVent™ fabric, including DryVent™ 2.5L, is engineered to allow water vapor to pass through from the inside to the outside. (Ex. A at p. 1.)</p>
27	A water-proof composition comprising:	<p>VF Outdoor infringes Claim 27 of the '287 Patent. The specific Infringing Products that Cocona asserts infringe this claim are described in Ex. A. For each specific Infringing Product that is asserted as infringing this claim, Cocona incorporates by reference herein the descriptions of those Infringing Products as set forth in Ex. A. Cocona reserves the right to amend and identify additional Infringing Products following claim construction or to the extent that Cocona identifies during discovery additional VF Outdoor products not listed in Ex. A that incorporate the DryVent™ 2.5L fabric or to the extent that Cocona identifies other VF Outdoor products that incorporate similar fabrics that infringe the '287 Patent.</p> <p>Cocona contends that the preamble of Claim 27 is not limiting. However, if this Court construes the preamble to be limiting, Cocona contends that VF Outdoor infringes this claim because each of the Infringing Products incorporate a water-proof composition marketed by VF Outdoor and/or TNF under the name DryVent™ 2.5L. (<i>See</i> Ex. A.) According to VF Outdoor, all DryVent™ fabrics, including DryVent™ 2.5L, are “engineered to be fully waterproof, windproof and breathable....” (<i>Id.</i> at p. 1.)</p>
a.	a liquid-impermeable breathable cured base	The DryVent™ 2.5L fabric includes a liquid-impermeable breathable cured base material in the form of a polyurethane (PU) layer that comprises a first thickness. According to VF

CLAIM No.	‘287 CLAIM LANGUAGE	INFRINGING PRODUCTS
	material comprising a first thickness;	Outdoor, DryVent™ 2.5L is a waterproof, breathable technology that utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. The durable water repellant finish helps form droplets and repel water from the surface. Each multi-layered textile is engineered to allow water vapor to pass through from the inside to the outside. ( <i>See, e.g., Ex. A. at pp. 1-2.</i> )
b.	a plurality of active particles in contact with the liquid impermeable breathable cured base material, the plurality of active particles comprising a second thickness; and	Micrographs of a cross-section of a sample of a DryVent™ 2.5L fabric show a plurality of active particles dispersed throughout a print layer that comprises a second thickness and that is in contact with the liquid impermeable breathable cured polyurethane layer. ( <i>See Ex. B, Report of Analysis by Analytical Answers, Report No. 71751, dated October 27, 2016 (the “AA Report”) at p. 4.</i> )
c.	wherein, the first thickness comprises a thickness at least 2.5 times larger than the second thickness but less than an order of magnitude larger than the second thickness,	The polyurethane layer that comprises the first thickness of the DryVent™ 2.5L fabric measures at a thickness of approximately 33 microns. ( <i>Ex. B, AA Report at p. 12.</i> ) The print layer that comprises the second thickness of the DryVent™ 2.5L fabric measures at a thickness of approximately 4 microns. ( <i>Id. at 14.</i> ). The polyurethane layer that comprises a first thickness of the DryVent™ 2.5L fabric is more than 2.5 times larger than the print layer that comprises a second thickness of the DryVent™ 2.5L fabric but is less than an order of magnitude larger.
d.	the active particles improve the moisture vapor transport capacity of the composition, and	The porous active particles in the print layer of the DryVent™ 2.5L fabric contain silicon, oxygen, titanium, calcium, aluminum, and carbon elements. ( <i>Ex. B, AA Report at p. 3.</i> ) When incorporated into a composition as taught in the ‘287 Patent, active particles improve the moisture vapor transport capacity of a composition. ( <i>See Ex. C, Drying Rate Comparison summary from the Report on Total Heat Loss Measurement of Five Materials</i>

CLAIM No.	‘287 CLAIM LANGUAGE	INFRINGING PRODUCTS
		performed by the Center for Research on Textile Protection and Comfort (“T-PACC Report”) at p. 5.)
e.	a moisture vapor transmission rate of the water-proof composition comprises from about 600 g/m <sup>2</sup> /day to about 11000 g/m <sup>2</sup> / day.	The moisture vapor transmission rate of the DryVent™ 2.5L fabric is 750-800 g/m <sup>2</sup> /24 hours average. ( <i>See, e.g.</i> , Ex. A at pp. 2-10, 12, 14.)
35	The composition of claim 27, wherein the composition possesses odor absorbance properties at least in part due to the active particles.	VF Outdoor infringes Claim 35 of the ‘287 Patent. The specific Infringing Products that Cocona asserts infringe this claim are described in Ex. A. As set forth <i>infra</i> , the DryVent™ 2.5L fabric is a composition that infringes Claim 27 of the ‘287 Patent. The DryVent™ 2.5L fabric is incorporated into each of the Infringing Products and contains active particles, including silicon, oxygen, titanium, calcium, aluminum, and carbon elements. (Ex. B, AA Report, at p. 3.) Active particles that contain silicon, oxygen, titanium, calcium, aluminum, and carbon elements are known to possess odor absorbance properties. ( <i>See</i> Ex. D, KMI Zeolite Report at pp. 1, 12-14.) The DryVent™ 2.5L fabric possesses odor absorbance qualities at least in part due to the active particles incorporated into the DryVent™ 2.5L fabric.
36	The composition of claim 27, wherein the composition possesses quick drying properties at least in part due to the active particles.	VF Outdoor infringes Claim 36 of the ‘287 Patent. The specific Infringing Products that Cocona asserts infringe this claim are described in Ex. A. As set forth <i>infra</i> , the DryVent™ 2.5L fabric is a composition that infringes Claim 27 of the ‘287 Patent. The DryVent™ 2.5L fabric is incorporated into each of the Infringing Products and contains active particles, including silicon, oxygen, titanium, calcium, aluminum, and carbon elements. (Ex. B, AA Report, at p. 3.) When incorporated as taught in the ‘287 Patent, active particles improve the moisture vapor transport capacity of a composition and thus cause it to possess quick drying properties. ( <i>See</i> Ex. C, T-PACC Report at p. 5.) All



CLAIM No.	'287 CLAIM LANGUAGE	INFRINGEMENT PRODUCTS
		DryVent™ fabrics, including DryVent™ 2.5L, are engineered to be breathable. Each DryVent™ fabric, including DryVent™ 2.5L, is engineered to allow water vapor to pass through from the inside to the outside. ( <i>See</i> Ex. A at p. 1.)
37	The composition of claim 27, wherein the active particles are selected from the group consisting of: activated carbon, aluminum oxide (activated alumina), silica gel, soda ash, aluminum trihydrate, baking soda, p-methoxy-2-ethoxy ethyl ester cinnamic acid (cinoxate), zinc oxide, zeolites, titanium dioxide, molecular filter-type materials, and any suitable combination thereof.	VF Outdoor infringes Claim 37 of the '287 Patent. The specific Infringing Products that Cocona asserts infringe this claim are described in Ex. A. As set forth <i>infra</i> , the DryVent™ 2.5L fabric is a composition that infringes Claim 27 of the '287 Patent. The DryVent™ 2.5L fabric is incorporated into each of the Infringing Products and contains active particles including at least activated carbon, aluminum oxide, silica gel, and titanium dioxide or a combination thereof. (Ex. B, AA Report, at p. 3.)

## EXHIBIT A

### VF OUTDOOR INFRINGING PRODUCTS

# **DRYVENT™**

**SHOP DRYVENT™**

**DryVent™** fabrics are engineered to be fully waterproof, windproof and breathable. The outer face of the textile is treated with a durable water repellant finish that helps form droplets and repel water from the surface. Each multi layered textile is engineered to allow water vapor to pass through from the inside to the outside.

**DryVent™** fabrics are engineered in a variety, weights, textures and performance characteristics that allows us to provide maximum protection, performance and comfort for the user across all our active and lifestyle waterproof, breathable clothing and accessories.







All **DryVent™** clothing and accessories are fully seam sealed and designed with specific features that are relevant to the user's specific activity needs and conditions. All products that are fully taped, waterproof and breathable will be branded **DryVent™**.







([https://www.thenorthface.com/content/vfcorp/thenorthface/north-america/en\\_us/about-us/technology-innovation/technology/hyvent.html](https://www.thenorthface.com/content/vfcorp/thenorthface/north-america/en_us/about-us/technology-innovation/technology/hyvent.html) (last visited Jan. 5, 2017).)






## **DRYVENT™ 2.5L**





**DryVent™** fabrics using a 2.5 Layer construction are primarily used for highly active, fast and light pursuits, where light weight and packable is an essential requirement of the user. The inner layer is finished with a functional dry touch print that helps raise the fabric from the skin to provide comfort and enable the quick transfer of vapor through to the outside of the fabric. These fabrics are generally designed into unlined clothing and accessories for maximum light weight, packable, waterproof and breathable performance.

([https://www.thenorthface.com/content/vfcorp/thenorthface/north-america/en\\_us/about-us/technology-innovation/technology/hyvent.html](https://www.thenorthface.com/content/vfcorp/thenorthface/north-america/en_us/about-us/technology-innovation/technology/hyvent.html) (last visited Jan. 5, 2017); *see also*, [http://web.archive.org/web/20150209000652/http://www.thenorthface.com/en\\_US/innovation/product-technology/hyvent/](http://web.archive.org/web/20150209000652/http://www.thenorthface.com/en_US/innovation/product-technology/hyvent/) (last visited Jan. 9, 2017).)



VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men's/Women's Venture Jacket</div> <div></div>	<div><div><div>DETAILS</div><p>Be prepared for extreme backcountry weather with this lightweight, waterproof and windproof jacket that features a durable yet breathable ripstop exterior. Relaxed Fit and adjustable hood that leaves room for a helmet and extra layers.</p></div><div><div>BENEFITS</div><div><div>WATERPROOF Impenetrable moisture barrier to guarantee dryness.</div><div>WIND PROTECTION Limiting air penetration reduces the windchill factor.</div><div>BREATHABLE Lightweight fabrics that help regulate body temperature.</div></div></div></div> <div><div>FEATURES</div><div><div><ul style="list-style-type: none"><li>• Unlined, packable, weatherproof rain jacket for year-round use</li><li>• Relaxed Fit</li><li>• Waterproof, breathable, seam-sealed DryVent™ 2.5L shell</li><li>• 100% windproof fabric</li><li>• Adjustable hood</li><li>• Velcro® stormflap covers front zipper</li></ul></div><div><ul style="list-style-type: none"><li>• Pit-zip venting for added breathability</li><li>• Covered, secure-zip hand pockets</li><li>• Velcro® adjustable cuff tabs</li><li>• Hem cinch-cord</li><li>• Packs into its own pocket</li></ul></div></div></div> <div><div>PRODUCT SPECIFICATIONS</div><div><div><div>STYLE: NF0A2VD3</div><div>AVG WEIGHT: 330 g (11.6 oz)</div><div>CENTER BACK: 29"</div><div>SOLID: 40D 85 g/m² DryVent™ 2.5L—100% nylon ripstop</div><div>HEATHER: 70D 154 g/m² DryVent™ 2.5L—62% nylon, 38% polyester</div><div>RIPSTOP HEATHER: 70D 144 g/m² DryVent™ 2.5L—72% nylon, 28% polyester ripstop</div></div><div><div>SOURCE: Imported</div><div>GUARANTEE: Lifetime Warranty</div><div>CARE INSTRUCTIONS: Machine Wash</div></div></div></div> <div><div>DRYVENT™</div><div></div><div><p>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</p><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul><div>LEARN MORE</div></div></div>	<div><a href="https://www.thenorthface.com/shop/mens-venture-jacket-3?variationId=LDJ">https://www.thenorthface.com/shop/mens-venture-jacket-3?variationId=LDJ</a></div> <div><a href="https://www.thenorthface.com/shop/womens-venture-jacket-3?variationId=HCL">https://www.thenorthface.com/shop/womens-venture-jacket-3?variationId=HCL</a></div> <div>(last visited Jan. 5, 2017)</div> <div><div>See also,</div><div><a href="https://web.archive.org/web/20150603190913/https://www.thenorthface.com/shop/mens">https://web.archive.org/web/20150603190913/https://www.thenorthface.com/shop/mens</a></div><div><a href="https://web.archive.org/web/20150603190811/https://www.thenorthface.com/shop/womens-jackets-vests">https://web.archive.org/web/20150603190811/https://www.thenorthface.com/shop/womens-jackets-vests</a></div><div>(last visited Jan. 6, 2017)</div></div>

VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men's/Women's Venture 2 Jacket</div> <div></div>	<div><div><div><b>DETAILS</b></div><div>Be prepared for extreme backcountry weather with this lightweight, waterproof and windproof jacket that features a durable yet breathable ripstop exterior, Relaxed Fit and adjustable hood that leaves room for a helmet and extra layers.</div></div><div><div><div><b>WATERPROOF</b> Impenetrable moisture barrier to guarantee dryness.</div><div><b>WIND PROTECTION</b> Limiting air penetration reduces the windchill factor.</div><div><b>BREATHABLE</b> Lightweight fabrics that help regulate body temperature.</div></div></div><div><div><div><b>FEATURES</b></div><div><ul style="list-style-type: none"><li>• Unlined, packable, weatherproof rain jacket for year-round use</li><li>• Relaxed Fit</li><li>• Waterproof, breathable, seam-sealed DryVent™ 2.5L shell</li><li>• 100% windproof fabric</li><li>• Adjustable hood</li><li>• Velcro® stormflap covers front zipper</li><li>• Pit-zip venting for added breathability</li><li>• Covered, secure-zip hand pockets</li><li>• Velcro® adjustable cuff tabs</li><li>• Hem cinch-cord</li><li>• Packs into its own pocket</li></ul></div></div><div><div><div><b>PRODUCT SPECIFICATIONS</b></div><div><div><b>STYLE</b> NF0A2VD3</div><div><b>AVG WEIGHT:</b> 330 g (11.6 oz)</div><div><b>CENTER BACK:</b> 29"</div><div><b>SOLID:</b> 40D 85 g/m² DryVent™ 2.5L—100% nylon ripstop</div><div><b>HEATHER:</b> 70D 154 g/m² DryVent™ 2.5L—82% nylon, 38% polyester</div><div><b>RIPSTOP HEATHER:</b> 70D 144 g/m² DryVent™ 2.5L—72% nylon, 28% polyester ripstop</div></div><div><div><b>SOURCE:</b> Imported</div><div><b>GUARANTEE:</b> Lifetime Warranty</div><div><b>CARE INSTRUCTIONS:</b> Machine Wash</div></div></div></div><div><div><div><b>DRYVENT™</b></div><div></div><div>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</div><div><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul></div><div><a href="#">LEARN MORE</a></div></div></div></div></div>	<div><a href="https://www.thenorthface.com/shop/mens-venture-2-jacket-nf0a2vd3?variationId=K6P">https://www.thenorthface.com/sh op/mens-venture-2-jacket- nf0a2vd3?variationId=K6P</a></div> <div><a href="https://www.thenorthface.com/shop/womens-venture-2-jacket-nf0a2vcr?variationId=QAK">https://www.thenorthface.com/sh op/womens-venture-2-jacket- nf0a2vcr?variationId=QAK</a></div> <div>(last visited Feb. 9, 2017)</div>

VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Women’s Berrien Jacket</div> <div></div>	<div><div><div><div><div><b>DETAILS</b></div><div>Whether you’re trekking across the valley or kayaking remote coastlines, prepare for unpredictable weather conditions with this breathable, unlined rain jacket that delivers reliable windproof and waterproof coverage.</div></div></div><div><div><div><b>WATERPROOF</b> Impenetrable moisture barrier to guarantee dryness.</div><div><div><b>WIND PROTECTION</b> Limiting air penetration reduces the windchill factor.</div><div><div><b>BREATHABLE</b> Lightweight fabrics that help regulate body temperature.</div></div></div></div><div><div><div><div><b>FEATURES</b></div><div><ul style="list-style-type: none"><li>• Hooded rain jacket</li><li>• Relaxed Fit</li><li>• Waterproof, windproof and breathable DryVent™ 2.5L shell</li><li>• Adjustable hood</li></ul></div></div><div><div><ul style="list-style-type: none"><li>• Double center front stormflaps with hidden snap closure</li><li>• Adjustable snap cuffs</li><li>• Raised high-definition logos</li></ul></div></div></div></div><div><div><div><div><b>PRODUCT SPECIFICATIONS</b></div><div><div><div><b>STYLE:</b> NF0A2VCQ</div><div><b>AVG WEIGHT:</b> 410 g (14.46 oz)</div><div><b>CENTER BACK:</b> 28"</div><div><b>CAMO:</b> 50D 107 g/m² DryVent™ 2.5L—100% polyester</div><div><b>DENIM:</b> 50D 183 g/m² DryVent™ 2.5L—100% polyester</div><div><b>PRINT:</b> 75D 128 g/m² DryVent™ 2.5L—100% polyester</div></div><div><div><b>SOURCE:</b> Imported</div><div><b>GUARANTEE:</b> Lifetime Warranty</div><div><b>CARE INSTRUCTIONS:</b> Machine Wash</div></div></div></div><div><div><div><div><b>DRYVENT™</b></div><div></div></div><div><div>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It’s been lab- and field-tested to ensure the best possible durability and function.</div><div><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul></div><div><a href="#">LEARN MORE</a></div></div></div></div></div></div></div></div></div>	<div><a href="https://www.thenorthface.com/shop/womens-berrien-jacket-nf0a2vcq?variationId=QMJ">https://www.thenorthface.com/shop/womens-berrien-jacket-nf0a2vcq?variationId=QMJ</a></div> <div>(last visited Feb. 9, 2017)</div>

VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men's Leonidas 2 Jacket</div> <div></div>	<div><div><div><div><div><b>DETAILS</b></div><div>Get reliable protection from the elements even deep in the wilderness with this unlined water- and windproof DryVent™ jacket that features four-way stretch, strategically placed vents, and an adjustable hem and wrist cuffs to avoid snags on the trail.</div></div></div><div><div><div></div><div><b>WATERPROOF</b> Impenetrable moisture barrier to guarantee dryness.</div></div><div><div></div><div><b>WIND PROTECTION</b> Limiting air penetration reduces the windchill factor.</div></div></div></div><div><div><div><div><b>FEATURES</b></div><div><ul style="list-style-type: none"><li>• Unlined, lightweight weatherproof jacket</li><li>• Active Fit</li><li>• Waterproof, breathable, seam-sealed DryVent™ 2.5L shell</li><li>• 100% windproof fabric</li><li>• Adjustable hood with back vent</li></ul></div><div><ul style="list-style-type: none"><li>• Pit-zip venting for added breathability</li><li>• Waterproof polyurethane (PU) front zipper</li><li>• Secure-zip, PU hand pockets</li><li>• Velcro® adjustable cuff tabs</li><li>• Hem cinch-cord</li></ul></div></div></div><div><div><div><div><b>PRODUCT SPECIFICATIONS</b></div><div><div><div><b>STYLE:</b> NF0A2VET</div><div><b>AVG WEIGHT:</b> 345 g (12.2 oz)</div><div><b>CENTER BACK:</b> 29"</div><div><b>FABRIC:</b> 40D 89 g/m² DryVent™ 2.5L — 100% nylon with mechanical stretch</div><div><b>SOURCE:</b> Imported</div></div><div><div><b><del>GUARANTEE:</del></b> Lifetime Warranty</div><div><b><del>CARE INSTRUCTIONS:</del></b> Machine Wash</div></div></div></div><div><div><div><div><b>DRYVENT™</b></div><div></div></div><div><div>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</div><div><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul></div><div><b>LEARN MORE</b></div></div></div></div></div></div></div></div>	<div><a href="https://www.thenorthface.com/shop/mens-leonidas-2-jacket-nf0a2vet?variationId=TSF">https://www.thenorthface.com/shop/mens-leonidas-2-jacket-nf0a2vet?variationId=TSF</a></div> <div>(last visited Feb. 9, 2017)</div>



VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men’s/Women’s Thermoball™ Triclimate® Jacket</div> <div></div>	<div><div><div>FEATURES</div><div><ul style="list-style-type: none"><li>• 3-in-1 jacket has a waterproof, breathable DryVent™ 2.5L shell and a removable ThermoBall™-insulated inner jacket.</li><li>• [Outer Jacket] Relaxed fit</li><li>• Waterproof, breathable, seam-sealed DryVent™ 2.5L shell</li><li>• Zip-in-compatible integration with complementing garments from The North Face®</li><li>• Attached, fully adjustable hood</li><li>• Pit-zip venting</li><li>• Exposed, center front zip</li><li>• Concealed secure-zip chest and hand pockets</li></ul></div><div><ul style="list-style-type: none"><li>• Velcro® adjustable cuff tabs</li><li>• Hem cinch-cord</li><li>• Media compatible</li><li>• Raised high-definition logos</li><li>• Heathered fabric in select colorways</li><li>• [Inner Jacket] 10 g/ft² PrimaLoft® ThermoBall™ synthetic insulation throughout the body with 60 g PrimaLoft® Silver Insulation Eco in the sleeves, side panels and collar</li><li>• Secure-zip covered hand pockets</li></ul></div></div></div> <div><div><div>PRODUCT SPECIFICATIONS</div><div><div><div>STYLE:</div><div>NF0A2TCK</div></div><div><div>AVG WEIGHT:</div><div>780 g (27.5 oz)</div></div><div><div>CENTER BACK:</div><div>29"</div></div><div><div>SOLID OUTER:</div><div>75D 130 g/m² DryVent™ 2.5L—95% polyester, 5% elastane</div></div><div><div>HEATHER OUTER:</div><div>80D 133 g/m² DryVent™ 2.5L—95% polyester, 5% elastane</div></div><div><div>INNER:</div><div>30D 45 g/m² 100% nylon taffeta</div></div></div><div><div><div>INNER INSULATION:</div><div>10 g/ft² PrimaLoft® ThermoBall™ synthetic insulation; 60 g PrimaLoft® Silver Insulation Eco</div></div><div><div>SOURCE:</div><div>Imported</div></div><div><div>GUARANTEE:</div><div>Lifetime Warranty</div></div><div><div>CARE INSTRUCTIONS:</div><div>Machine Wash</div></div></div></div></div>	<div><a href="https://www.thenorthface.com/shop/mens-thermoball-triclimate-jacket-nf0a2tck?variationId=AVM">https://www.thenorthface.com/shop/mens-thermoball-triclimate-jacket-nf0a2tck?variationId=AVM</a></div> <div><a href="https://www.thenorthface.com/shop/womens-thermoball-triclimate-jacket-nf0a2tdk?variationId=GF5">https://www.thenorthface.com/shop/womens-thermoball-triclimate-jacket-nf0a2tdk?variationId=GF5</a></div> <div>(last visited Jan. 5, 2017)</div>

THERMOBALL



Developed in partnership with PrimaLoft, Inc., ThermoBall is a revolution in insulation technology. Unlike traditional continuous-filament synthetic insulation, the small, round PrimaLoft synthetic-fiber clusters closely mimic down clusters, trapping heat within small air pockets to retain warmth. Independent clo testing by Kansas State University has shown that ThermoBall has warmth equivalent to 800 fill goose down. As a result, ThermoBall can offer the lightweight warmth and compressibility of down with the wet-weather insulating performance of synthetic insulation.

LEARN MORE

DRYVENT™









This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.






- Waterproof Rating: 25 PSI minimum after 20 launderings
- Breathability: 750-800 g/m²/24 hours average






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VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men's/Women's Stormy Trail Jacket</div> <div></div>	<div><div><div>DETAILS</div><p>Prepare for long runs in stormy, low-light conditions with this sleek, streamlined running jacket that's waterproof and features an internal venting system for maximum breathability.</p></div><div><div>BENEFITS</div><div><div><div>WATERPROOF</div><p>Impenetrable moisture barrier to guarantee dryness.</p></div><div><div>REFLECTIVE</div><p>Maximize your visibility in low light for improved safety.</p></div><div><div>BREATHABLE</div><p>Lightweight fabrics that help regulate body temperature.</p></div></div></div><div><div>FEATURES</div><div><div><ul style="list-style-type: none"><li>Breathable, waterproof running jacket with an innovative venting system to maximize airflow</li><li>Media-compatible, secure-zip hand pockets</li><li>Internal venting system</li><li>360-degree reflectivity</li></ul></div><div><ul style="list-style-type: none"><li>Reflective print on shoulders and arms</li><li>Hem cinch</li><li>Rain skirt</li></ul></div></div></div><div><div>PRODUCT SPECIFICATIONS</div><div><div><div>STYLE: NF0A2TGZ</div><div>CENTER BACK: 29.5"</div><div>BODY: 92 g/m² DryVent™ 2.5L—100% nylon ripstop</div><div>PANEL: 115 g/m² 100% polyester double knit</div><div>SOURCE: Imported</div></div><div><div>GUARANTEE: Lifetime Warranty</div><div>CARE INSTRUCTIONS: Machine Wash</div></div></div></div><div><div><div>DRYVENT™</div></div><div><p>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</p><ul style="list-style-type: none"><li>Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>Breathability: 750-800 g/m²/24 hours average</li></ul><a href="#">LEARN MORE</a></div></div></div>	<div><a href="https://www.thenorthface.com/shop/mens-stormy-trail-jacket-nf0a2tgz?variationId=HDC">https://www.thenorthface.com/shop/mens-stormy-trail-jacket-nf0a2tgz?variationId=HDC</a></div> <div><a href="https://www.thenorthface.com/shop/womens-stormy-trail-jacket-nf0a2tie?variationId=128">https://www.thenorthface.com/shop/womens-stormy-trail-jacket-nf0a2tie?variationId=128</a></div> <div>(last visited Jan. 5, 2017)</div> <div>See also,</div> <div><a href="https://web.archive.org/web/20150603210625/https://www.thenorthface.com/shop/mens-jackets-vests-running-training">https://web.archive.org/web/20150603210625/https://www.thenorthface.com/shop/mens-jackets-vests-running-training</a></div> <div>(last visited Jan. 6, 2017)</div>










VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<p>Women’s Novelty Venture Jacket</p> 	<div><div><h3>DETAILS</h3><p>Ready for backcountry storms or everyday excursions, this waterproof, windproof hooded women's jacket is designed to protect you from rain, year round. The printed exterior of this breathable DryVent™ 2.5L soft-shell is finished with a dry-touch coating that eliminates the need for a mesh lining.</p></div><div><h3>BENEFITS</h3><div><div><p><b>WATERPROOF</b> Impenetrable moisture barrier to guarantee dryness.</p></div><div><p><b>PACKABLE/STOWABLE</b> Highly-compressible layer for emergency use or travel.</p></div><div><p><b>WIND PROTECTION</b> Limiting air penetration reduces the windchill factor.</p></div></div></div><div><h3>FEATURES</h3><div><div><ul style="list-style-type: none"><li>• Waterproof, windproof, seam-sealed DryVent™ 2.5L shell</li><li>• Relaxed</li><li>• Attached, fully adjustable hood</li><li>• Front stormflap with snap closure</li><li>• Pit-zip venting</li></ul></div><div><ul style="list-style-type: none"><li>• Secure-zip covered hand pockets</li><li>• Snap adjustable cuff tabs</li><li>• Hem cinch-cord</li><li>• High-definition logos</li><li>• Stowable in hand pocket</li></ul></div></div></div><div><div><h3>PRODUCT SPECIFICATIONS</h3><div><div><p><b>STYLE:</b> CVL0</p><p><b>AVG WEIGHT:</b> 300 g (10.58 oz)</p><p><b>CENTER BACK LENGTH:</b> 27"</p><p><b>CAMO:</b> 137 g/m² DryVent™ 2.5L—100% polyester jacquard</p><p><b>STRIPE:</b> 168 g/m² DryVent™ 2.5L—95% nylon, 5% polyester</p></div><div><p><b>SOURCE:</b> Imported</p><p><b>GUARANTEE:</b> Lifetime Warranty</p><p><b>CARE INSTRUCTIONS:</b> Machine Wash</p></div></div></div><div><div><p><b>DRYVENT™</b></p></div><div><p>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</p><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul><p><b>LEARN MORE</b></p></div></div></div></div>	<p><a href="https://www.thenorthface.com/shop/womens-novelty-venture-jacket-cvl0?variationId=HHL">https://www.thenorthface.com/shop/womens-novelty-venture-jacket-cvl0?variationId=HHL</a></p> <p>(last visited Jan. 5, 2017)</p>

VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<p>Women’s Lynwood Parka</p> 	<div><div><h3>DETAILS</h3><p>Cycle to work day in, day out with this windproof and waterproof DryVent™ parka with an adjustable hood and added length to protect you from wet bike seats and splashing puddles.</p></div><div><h3>BENEFITS</h3><div><div><b>WATERPROOF</b> Impenetrable moisture barrier to guarantee dryness.</div><div><b>WIND PROTECTION</b> Limiting air penetration reduces the windchill factor.</div><div><b>BREATHABLE</b> Lightweight fabrics that help regulate body temperature.</div></div></div></div> <div><div><h3>FEATURES</h3><ul style="list-style-type: none"><li>• Unlined, breathable, long rain jacket</li><li>• Waterproof, windproof, breathable DryVent™ 2.5L shell</li><li>• Adjustable hood</li><li>• Inset elastic at side and back waist to enhance fit</li><li>• Secure-zip hand pockets</li><li>• Adjustable snap cuffs</li><li>• Raised logos on chest and back</li></ul></div><div><h3>PRODUCT SPECIFICATIONS</h3><div><div><b>STYLE:</b> NF0A2VFN</div><div><b>AVG WEIGHT:</b> 420 g (14.81 oz)</div><div><b>CENTER BACK:</b> 32"</div><div><b>BODY:</b> 75D 124 g/m² DryVent™ 2.5L—100% polyester</div><div><b>LINING:</b> 70D 63 g/m² 100% nylon</div></div><div><div><b>SOURCE:</b> Imported</div><div><b>GUARANTEE:</b> Lifetime Warranty</div><div><b>CARE INSTRUCTIONS:</b> Machine Wash</div></div></div></div> <div><div><h3>DRYVENT™</h3></div><div><p>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</p><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul><p><a href="#">LEARN MORE</a></p></div></div>	<p><a href="https://www.thenorthface.com/shop/womens-lynwood-parka-nf0a2vfn?variationId=NXJ">https://www.thenorthface.com/shop/womens-lynwood-parka-nf0a2vfn?variationId=NXJ</a></p> <p>(last visited Feb. 9, 2017)</p>






VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Women’s Teralinda Trench</div> <div></div>	<div><div><div>DETAILS</div><p>Navigate the city streets in this belted trench coat that’s crafted with a longer 34" length for extra coverage and a waterproof exterior that features a subtle dot print.</p></div><div><div>BENEFITS</div><div><div><div>WATERPROOF</div><p>Impenetrable moisture barrier to guarantee dryness.</p></div><div><div>INSULATED</div><p>Insulation traps hot air for reduced heat loss and increased warmth.</p></div><div><div>WIND PROTECTION</div><p>Limiting air penetration reduces the windchill factor.</p></div></div></div><div><div>FEATURES</div><div><div><ul style="list-style-type: none"><li>• Waterproof trench coat with a longer 34" length</li><li>• Fixed hood with adjustability</li><li>• Two-way center front zip behind a kissing welt</li><li>• Reversible belt with reflective tape on back waist</li><li>• Internal media pocket</li></ul></div><div><ul style="list-style-type: none"><li>• Key clip in hand pocket</li><li>• Hand pockets</li><li>• Tailored vent at back hem</li><li>• Rounded drop tail</li><li>• Embroidered logo on chest and back shoulder</li></ul></div></div></div><div><div>PRODUCT SPECIFICATIONS</div><div><div>STYLE: CG1A</div><div>CARE INSTRUCTIONS: Machine Wash</div><div>CENTER BACK LENGTH: 34"</div><div>AVG WEIGHT: 420 g (14.82 oz)</div></div></div><div><div>DRYVENT™</div><div></div><div><p>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</p><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul><div>LEARN MORE</div></div></div></div>	<div><a href="https://www.thenorthface.com/shop/womens-teralinda-trench-cg1a?variationId=V1U">https://www.thenorthface.com/shop/womens-teralinda-trench-cg1a?variationId=V1U</a></div> <div>(last visited Jan. 5, 2017)</div>

VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men's Fuseform™ Dot Matrix Jacket</div> <div></div>	<div><div><div><b>DETAILS</b></div><p>Ready for vertical movement, this technical, waterproof rain shell is ultralight yet hyper-durable thanks to our FuseForm construction that seamlessly integrates strong nylon yarns at the shoulders and breathable polyester yarns through the torso for targeted abrasion resistance.</p></div><div><div><b>WATERPROOF</b> Impenetrable moisture barrier to guarantee dryness.</div><div><b>BREATHABLE</b> Lightweight fabrics that help regulate body temperature.</div></div></div> <div><div><div><b>FEATURES</b></div><div><ul style="list-style-type: none"><li>• Technical rain shell engineered with FuseForm™ construction for targeted durability</li><li>• Innovative FuseForm construction seamlessly fuses light and strong fibers for targeted durability</li><li>• Active fit</li><li>• Waterproof, breathable, seam-sealed DryVent™ 2.5L shell with hex gradient design</li><li>• Engineered yoke for durability and fewer seams</li><li>• Attached, fully adjustable hood with hidden cord locks</li></ul></div><div><ul style="list-style-type: none"><li>• Center front zip</li><li>• Pit-zip venting</li><li>• Pack-friendly zip hand pockets</li><li>• Velcro® adjustable cuff tabs</li><li>• Hem cinch-cord</li><li>• Media compatible</li></ul></div></div></div> <div><div><div><b>PRODUCT SPECIFICATIONS</b></div><div><div><b>STYLE:</b> CUW3-C1</div><div><b>AVG WEIGHT:</b> 480 g</div><div><b>CENTER BACK LENGTH:</b> 27.5"</div><div><b>FABRIC:</b> 50D x 70D + 75D 109 g/m² DryVent™ 2.5L—53% polyester, 47% nylon engineered FuseForm™ plain weave</div><div><b>SOURCE:</b> Imported</div></div><div><div><b>GUARANTEE:</b> Lifetime Warranty</div><div><b>CARE INSTRUCTIONS:</b> Machine Wash</div></div></div></div>	<div><a href="https://www.thenorthface.com/shop/mens-fuseform-dot-matrix-jacket-cuw3-c1?variationId=CGN">https://www.thenorthface.com/shop/mens-fuseform-dot-matrix-jacket-cuw3-c1?variationId=CGN</a></div> <div>(last visited Jan. 5, 2017)</div>

VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men's Flight Series™ Fuse Jacket</div> <div></div>	<div><div><div>DETAILS</div><p>Run cool, dry and protected in wet conditions with our lightest-weight weather-resistant jacket that features a durable yet minimal FuseForm™ construction with perforated ventilation to maximize breathability.</p></div><div><div>BENEFITS</div><div><div>WIND PROTECTION</div><p>Limiting air penetration reduces the windchill factor.</p><div>REFLECTIVE</div><p>Maximize your visibility in low light for improved safety.</p><div>BREATHABLE</div><p>Lightweight fabrics that help regulate body temperature.</p></div></div></div> <div><div>FEATURES</div><div><div><ul style="list-style-type: none"><li>• Our lightest-weight wind- and water-resistant jacket</li><li>• Flight Series™ performance running gear is race-day ready</li><li>• Durable, lightweight FuseForm™ engineered ventilation with perforated membrane in key areas</li></ul></div><div><ul style="list-style-type: none"><li>• Secure-zip chest pocket</li><li>• Adjustable hem</li><li>• 360-degree reflectivity and reflective logos</li></ul></div></div></div> <div><div>PRODUCT SPECIFICATIONS</div><div><div><b>STYLE:</b> NF0A2TGU</div><div><b>CENTER BACK:</b> 29.5"</div><div><b>FABRIC:</b> 53 g/m² DryVent™ 2.5L—100% nylon with engineered breathability</div><div><b>SOURCE:</b> Imported</div><div><b>GUARANTEE:</b> Lifetime Warranty</div><div><b>CARE INSTRUCTIONS:</b> Machine Wash</div></div></div> <div><div><div><b>DRYVENT™</b></div><div></div></div><div><p>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</p><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul><p><b>LEARN MORE</b></p></div></div>	<div><a href="https://www.thenorthface.com/shop/mens-flight-series-fuse-jacket-nf0a2tgu?variationId=A0M">https://www.thenorthface.com/shop/mens-flight-series-fuse-jacket-nf0a2tgu?variationId=A0M</a></div> <div>(last visited Jan. 5, 2017)</div>

VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<div>Men’s Fuseform™ Cesium Anorak</div> <div></div>	<div><div><div><b>DETAILS</b></div><div>Designed to provide technical outdoor protection that's also highly packable, our lightest FuseForm outdoor shell jacket delivers targeted durability with 15D ripstop nylon across the arms and shoulders that seamlessly transitions through the woven torso.</div></div><div><div><b>BENEFITS</b></div><div><div></div><div><b>BREATHABLE</b> Lightweight fabrics that help regulate body temperature.</div></div></div></div> <div><div><div><b>FEATURES</b></div><div><div><ul style="list-style-type: none"><li>• Technical, waterproof rain anorak with a minimalist design</li><li>• FuseForm™ construction seamlessly transitions from ripstop to plain weave for targeted durability</li><li>• Alpine fit allows freedom of movement in mountain environments</li><li>• Waterproof, breathable, seam-sealed DryVent™ 2.5L shell</li><li>• Comfortable dry-touch coating eliminates the need for a liner</li></ul></div><div><ul style="list-style-type: none"><li>• Engineered yoke and sleeves for durability and fewer seams</li><li>• Molded-tooth center front half zip</li><li>• Secure-zip polyurethane (PU) chest pocket</li><li>• Elastic-bound cuffs and hem</li></ul></div></div><div><div><div><b>PRODUCT SPECIFICATIONS</b></div><div><div><b>STYLE:</b> CF4X-C1</div><div><b>AVG WEIGHT:</b> 520 g</div><div><b>CENTER BACK LENGTH:</b> 29"</div><div><b>FABRIC:</b> 15D 63 g/m² DryVent™ 2.5L—100% nylon engineered from ripstop to plain weave</div></div><div><div><b>SOURCE:</b> Imported</div><div><b>GUARANTEE:</b> Lifetime Warranty</div></div></div></div></div><div><div><a href="https://www.thenorthface.com/shop/mens-fuseform-cesium-anorak-cf4x-c1?variationId=FEP">https://www.thenorthface.com/shop/mens-fuseform-cesium-anorak-cf4x-c1?variationId=FEP</a>  (last visited Jan. 5, 2017)</div></div></div>	



VF OUTDOOR – DRYVENT™ 2.5L		
PRODUCT	DESCRIPTION	REFERENCE
<p>Men's/Women's Venture 2 Half Zip Pants</p> 	<div><div><h3>DETAILS</h3><p>Take varied terrain and weather conditions in stride with easy-to-layer, lightweight women's DryVent™ rain pants. An elastic waist, knee-high side zippers, and Velcro®-tabbed ankles allow you to dial in the fit with ease and stay dry in wet conditions.</p></div><div><h3>BENEFITS</h3><div><div><b>WATERPROOF</b> Impenetrable moisture barrier to guarantee dryness.</div><div><b>WIND PROTECTION</b> Limiting air penetration reduces the windchill factor.</div><div><b>BREATHABLE</b> Lightweight fabrics that help regulate body temperature.</div></div></div><div><div><h3>FEATURES</h3><ul style="list-style-type: none"><li>• Unlined waterproof rain pants with side zippers</li><li>• Relaxed Fit</li><li>• Waterproof, breathable, seam-sealed DryVent™ 2.5L shell pant</li><li>• 100% windproof fabric</li><li>• Elastic waist with drawcord</li><li>• Secure-zip hand pockets</li><li>• Packs into its own pocket</li><li>• Knee-length side zips</li><li>• Velcro® adjustable ankle tabs</li></ul></div><div><h3>PRODUCT SPECIFICATIONS</h3><div><div><b>STYLE:</b> NF0A35E6</div><div><b>AVG WEIGHT:</b> 230 g (8.11 oz)</div><div><b>INSEAM:</b> S 30, R 32", L 34</div><div><b>SOLID:</b> 40D 85 g/m² DryVent™ 2.5L—100% nylon ripstop</div><div><b>HEATHER:</b> 70D 154 g/m² DryVent™ 2.5L—62% nylon, 38% polyester</div></div><div><div><b>SOURCE:</b> Imported</div><div><b>GUARANTEE:</b> Lifetime Warranty</div><div><b>CARE INSTRUCTIONS:</b> Machine Wash</div></div></div></div></div> <div><div><div><b>DRYVENT™</b></div></div><div><p>This waterproof, breathable technology utilizes a polyurethane (PU) coating that consists of a tri-component, multi-layer formula for waterproof protection, moisture permeability and durability. It's been lab- and field-tested to ensure the best possible durability and function.</p><ul style="list-style-type: none"><li>• Waterproof Rating: 25 PSI minimum after 20 launderings</li><li>• Breathability: 750-800 g/m²/24 hours average</li></ul><p><b>LEARN MORE</b></p></div></div>	<p><a href="https://www.thenorthface.com/shop/womens-venture-2-half-zip-pants-nf0a35e6?variationId=DYY">https://www.thenorthface.com/shop/womens-venture-2-half-zip-pants-nf0a35e6?variationId=DYY</a></p> <p><a href="https://www.thenorthface.com/shop/mens-venture-2-half-zip-pants-nf0a2vd4?variationId=DYZ">https://www.thenorthface.com/shop/mens-venture-2-half-zip-pants-nf0a2vd4?variationId=DYZ</a></p> <p>(last visited Feb. 9, 2017)</p>



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October 27, 2016

Mr. Gregory Haggquist, Ph.D.  
Cocona, Inc.  
5480 Valmont Road, Suite 300  
Boulder, CO 80301

**Report No:** 71751

**P.O. No:** 7318

**PURPOSE OF ANALYSIS:**

To characterize dark gray to black printing on the inside of one (1) light, nylon-shell 'wind breaker' jacket, with the objective of characterizing particle size, morphology, ink thickness and composition.

**SAMPLES:**

One (1) wind breaker style jacket, identified as "North Face", see micrograph M-01.

**METHODS OF ANALYSIS:**

Sample Preparation  
Micro-Fourier Transform Infrared Spectroscopy (FTIR)  
Thermo Gravimetric Analysis (TGA)  
Focused Ion Beam (FIB)  
Ultra-Field Emission Scanning Electron Microscopy (UFESM)/Energy Dispersive X-Ray Spectroscopy (EDS)

**CONCLUSIONS:**

The jacket had an overall structure of a woven outer shell coated with a porous polymer material over which the ink had been applied.

The North Face ink layer contained silicon based particles (presumably oxide), but these were primarily very fine particles (tens of nanometers in diameter).

We did not find any abundance of observable carbon based filler particles in the ink layer. This could be interpreted as either the samples contained particles of a size which could not be resolved i.e., less than 5 nm in diameter using this technique, or that such particles were not present.



The porous polymer base material in the North Face sample contained silicon and titanium. In general, these results are consistent with the analysis of the TGA residues, which found significant Si and Ti in the North Face residue.

### **COMMENTS:**

When looking at the TGA residues to examine morphology, several factors related to the composition made this difficult. Since the jacket had significant amounts and sizes of other fillers, looking for different types of carbon particles was hindered.

Examination of the cross sections was more straightforward than the TGA residues, because the fillers in individual layers could be seen and identified. Despite this advantage, the ink fillers were still found to be not carbon based, consisting mainly of silicon particles of different sizes.

### **RESULTS:**

Micrograph M-01 document the identification of the sample.

### **Phase I - Microstructure Comparison and Thermal Analysis**

#### ***Sample Preparation:***

Although each technique below requires specific sample preparation steps, this section documents our overall sample preparation. From the jacket, an ~6" x 8" square section was cut from the back, near the bottom edge but well away from any sewn or (apparently) heat-sealed seams. From this section, smaller portions were cut away for each of the techniques below. Filtered air was used to blow off any particulates and fibers which the fabric may have picked up in handling.

#### ***Micro-Fourier Transform Infrared Spectroscopy (FTIR):***

Using macroscopic Attenuated Total Reflectance (ATR) sampling, spectra were taken of the outside and inside of the jacket. This was supplemented using Micro Attenuated Total Reflectance (uATR) sampling specific to the black ink printing on the inside surface. Acquired spectra were identified by eye and by comparison to AAI's reference libraries of 220,000+ compounds and commercial formulations. The objective of this analysis was to verify expected composition, such that the appropriate thermal profile for TGA analysis could be selected.

From the outside of the jacket, spectral features were found to indicate the material was based on Nylon 6 (PA-6) fibers. (Please note that while a particular brand name or manufacturer may be presented in our comparison plots, this does not conclusively identify the source of the material.

FTIR analysis can not differentiate between different manufacturers producing chemically equivalent products.)



On the inside of the jacket, the inside surface was found to be consistent with a polyether-based polyurethane, and like the nylon outside, representative of resins available from a variety of different commercial sources.

Using the uATR sampling, spectra were taken of the ink printing from the inside of the jacket. We note a strong baseline offset and tilt indicating the presence of infrared inactive and scattering materials such as carbon black, black metal oxides, black metal sulfides, and possibly others. The ink binder matrix appears nearly identical with the inside polyurethane formulation, with the addition of a large peak in the silica/silicate Si-O stretch region suggesting the presence of additional silica/silicate in the ink formulation. Note FTIR is relatively ineffective at such inorganic analysis, please see the EDS results for elemental analysis.

#### ***Thermo Gravimetric Analysis (TGA):***

Based on the FTIR findings of a Nylon 6 fiber coated with a polyether-based polyurethane with the same, or similar, polyether urethane in the ink binder, a temperature profile ramping from room temperature up to 300°C at 15°C/min was used at the start. Afterwards, the temperature was gradually raised to 550°C at 5°C/min, and then held for one minute. The TGA sample chamber was continually purged with dry nitrogen to prevent 'burning' of residual carbon.

Under these conditions, the decomposition profile had one major mass loss occurring at ~420°C, corresponding to the nylon decomposition, and a second at ~450°C, corresponding to the polyurethane decomposition. The sample reached a stable mass well before the end of the run, indicating complete decomposition of the polymer matrix under these conditions. However, the sample showed a ~12% residual mass at the end of the analysis. As we were only expecting residual carbon (either carbon black or amorphous activated carbon), along with residual silica/silicates and other inorganics (if any) from the ink printing, we now suspect the residual mass to be a combination of residual carbon, inorganics, and carbon 'char' from polymer decomposition.

#### ***Ultra Field Emission Scanning Electron Microscopy (UFSEM)/Energy Dispersive X-Ray Spectroscopy (EDS) on TGA Residues for Morphological Comparison***

##### North Face TGA Residue

Micrographs M-02 through M-06 are secondary electron images obtained at 1 kX, 5 kX, 25 kX, 100 kX, and 200 kX magnifications of a select region of the North Face TGA residue sample.

Micrograph M-07 is a secondary electron image of the region where EDS analysis was performed on the North Face TGA residue sample. Mainly carbon, oxygen, silicon, and titanium were present. Also, trace amounts of sodium, aluminum, sulfur, titanium, and calcium were present as well. See the attached spectrum X-01 for full details.

Some of these elements found in the TGA residue are likely also fillers from the base materials below the ink. During the cross section analysis, we will determine which major elements originate in which layer(s).



## **Phase II - Cross Section Analysis for Ink Thickness and Particle Morphology**

### ***Sample Preparation:***

For Phase I of the analyses, an ~6" x 8" square section was cut from the back of the jacket, near the bottom edge but well away from any sewn or (apparently) heat-sealed seams. From these same sections, smaller portions (~1/2 square inch) were cut away. The cross-sectional face of interest was then prepared using a vertical cut with a clean razor blade to give a sharp edge. The sample was then mounted onto a piece of silicon wafer using carbon paint along the non-analytical edges to facilitate handling. A thin sputter deposited gold coating was then applied (~4 nm) followed by an evaporative carbon coating. This is standard prep for FIB analysis to protect the surface of interest and to alleviate any surface charging. Once in the FIB instrument a layer of platinum was deposited over the surface to be FIB milled, again to protect the surface of interest from ion beam damage.

### ***Focussed Ion Beam (FIB) Cross-Section followed by Ultra-Field Emission Scanning Electron Microscopy (UFEBSEM)/Energy Dispersive X-Ray Spectroscopy (EDS):***

FIB milling areas were positioned to give views of various ink locations for each sample as well as an ink-free (blank) area. This process removes damage from the razor cut process, leaving a smoother, defect free surface suitable for high resolution imaging.

M-08 shows the patterning present on the North Face sample. Cross-sections were attempted from each of the dot features present in lines consisting of 3 dots. Micrograph M-09 shows a low magnification (100x) secondary electron image from the sample. It shows a woven outer shell of the jacket (bottom layer in the image) with a porous polymer layer on top.

### **North Face Sample**

Micrographs M-10 and M-11 show a comparison of the North Face cross-sections from a blank (no ink) area and an area with a square ink dot. The North Face material shows a variety of small particulates dispersed within the base porous polymer. Large porous particles are also seen, and these large porous particles also throughout the porous polymer and are not confined to the ink. While the ink interfaces are hard to locate precisely, a measurement of the ink thickness for two different dot areas (center of a 3 dot wide line and the left and right edge dots again from a 3 dot line) are shown in Micrographs M-12, M-13 and M-14.

Micrographs M-15 through M-21 show higher magnification images of the ink and blank regions. EDS was performed to ascertain the composition of various features. The results are summarized below. The larger porous particles dispersed throughout the polymer are SiO<sub>2</sub> based. This is consistent with the EDS analysis of the TGA residue. The clusters of small particles in the base polymer indicate a Ti based filler.

The enclosed data present the results.

The enclosed data sheets further describe the Micro-Fourier Transform Infrared Spectroscopy (FTIR), Thermo Gravimetric Analysis (TGA), Energy Dispersive X-Ray Spectroscopy (EDS), Ultra Field Emission Scanning Electron Microscopy (UFESM) and Focused Ion Beam (FIB) analytical techniques.

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William C. Harris  
FIB Microscopist/  
Sr. Surface Scientist

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Failure Analysis Specialist

JRP/WCH/JFB/lam

Enclosures:	Samples:	1 Wind Breaker Style Jacket
	Micrographs:	24 Embedded & 46 Included on CD
	Spectra:	11 EDS, 5 FTIR and 1 TGA
	Tables:	4
	Index Prints:	2
	CD:	1
	Data Sheet:	5
	Evaluation:	1

**Table I: EDS Data Summary of TGA Residues and Reference Materials**

Spectra	Sample	Micrograph	Elements Detected
X-01	North Face TGA Residue	M-07	C, O, Na, Si, S, Ti, Ca, Ir*

\* ~1nm of iridium was applied to the samples prior to analysis at AAI. The observed iridium is suspected to be from this process.

**Table II: North Face Cross- Section EDS Data Summary**

Spectra	Feature	Micrograph	Elements Detected
X-02	Cluster of small bright contrast particles in porous polymer base	M-22	C, O, Ti, Si, N, Ga*
X-03	Large porous particle in base	M-22	Si, C, O, N, Ti,
X-04	Large porous particle in base	M-22	Si, C, O, N, Ti,
X-05	Ink area fine particles	M-23	C, O, Si, N
X-06	Bright contrast cluster of particles in base	M-23	C, O, Ti, Si, N, Al
X-07	Large porous particle in base	M-23	Si, O, C, N
X-08	Ink area fine particles	M-24	C, O, Si, N, Pt*
X-09	Large porous particle in base	M-24	Si, C, O, N, Pt*, Ga*, Ti
X-10	Ink area off particles	M-24	C, O, Si, N, Pt*, Ga*

\* ~1  $\mu$ m of Platinum is applied in the FIB instrument to protect the surface of interest from the ion beam during milling. A Gallium ion beam is used in the instrument. Pt and Ga seen in some spectra are thus due to the FIB.



**Table III: Summary of Filler Materials**

<b>Sample</b>	<b>Substrate Fillers</b>	<b>Ink Fillers</b>
North Face	Si based (X-03, X-04, X-07) Ti based (X-02, X-06)	Si based, fine (X-05, X-08, X-10)

**Table IV: Summary of Ink Thickness Measurements**

<b>Sample</b>	<b>Feature</b>	<b>Measured Thickness (μm)</b>
North Face	Right edge dot	2.0, 2.1
North Face	Center dot	1.5, 4.1, 2.4
North Face	Left edge dot	0.7, 0.8, 1.8

\* Thickness measurements are estimates given difficulty in precisely determining polymer interface endpoint and thickness variability within the cross-sections.

M-01 ~0.5X

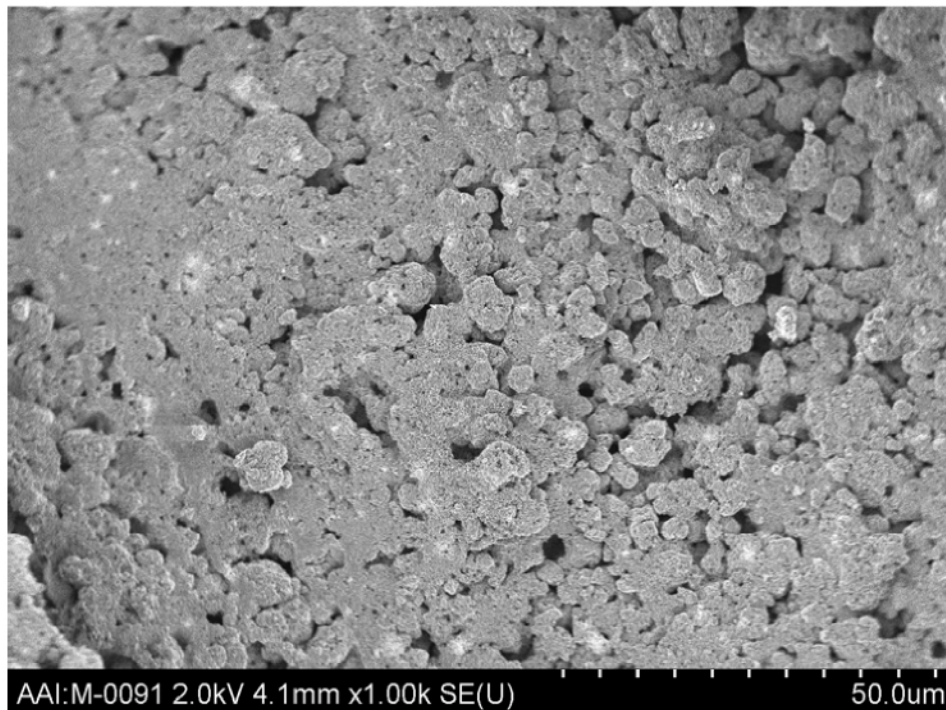
An optical image partial view  
of the North Face jacket  
as-received is shown.



Intentionally left blank

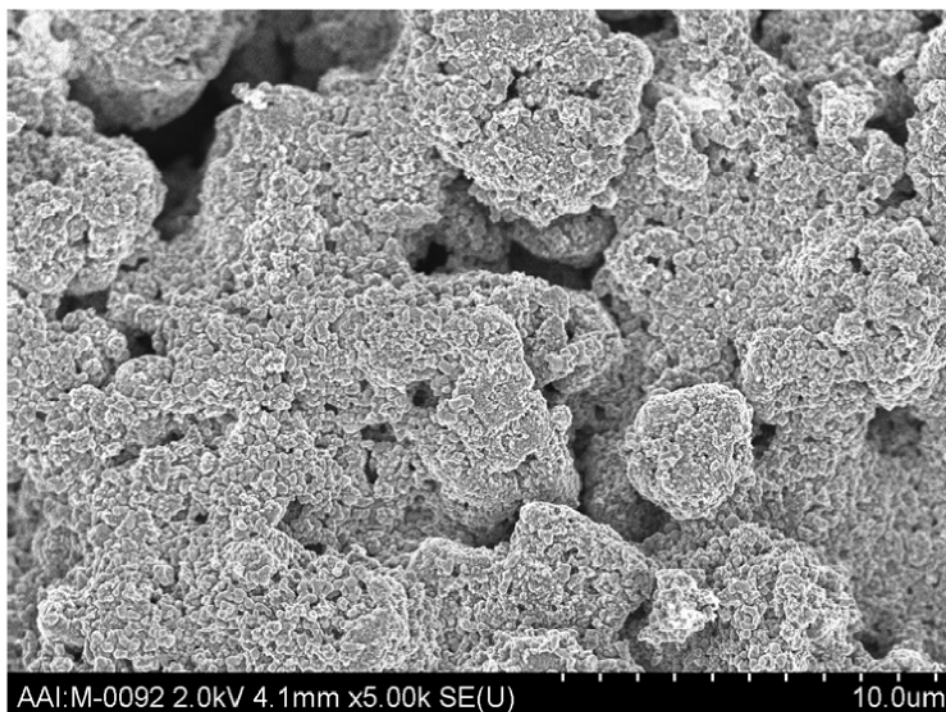
M-02 1,000X

A secondary electron image of a select region on the North Face TGA residue sample is shown.



M-03 5,000X

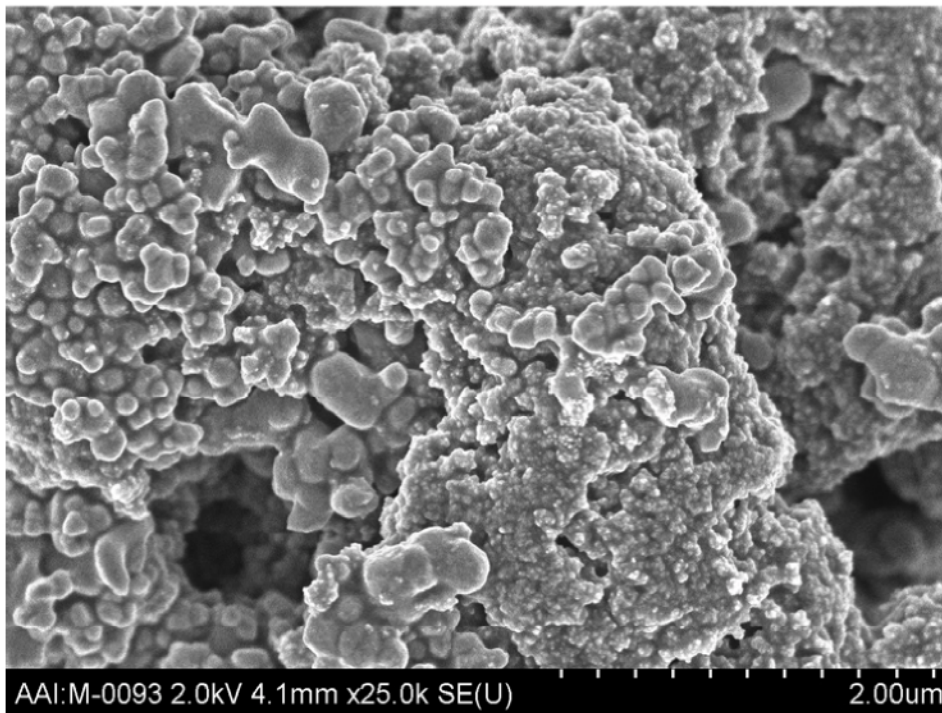
A secondary electron image of a select region on the North Face TGA residue sample is shown.





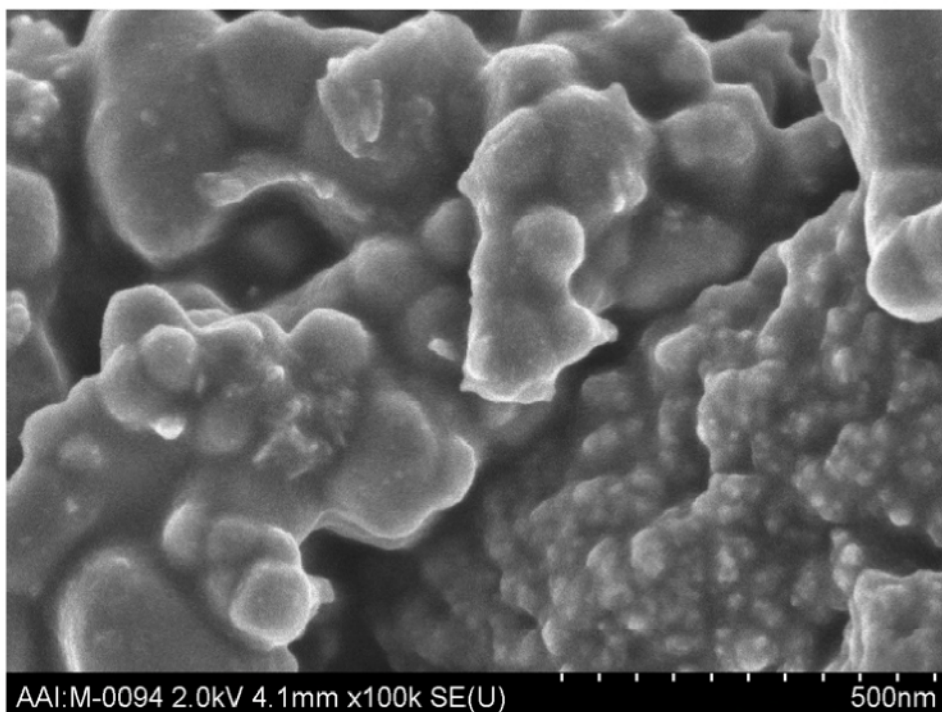
M-04 25,000X

A secondary electron image of a select region on the North Face TGA residue sample is shown.



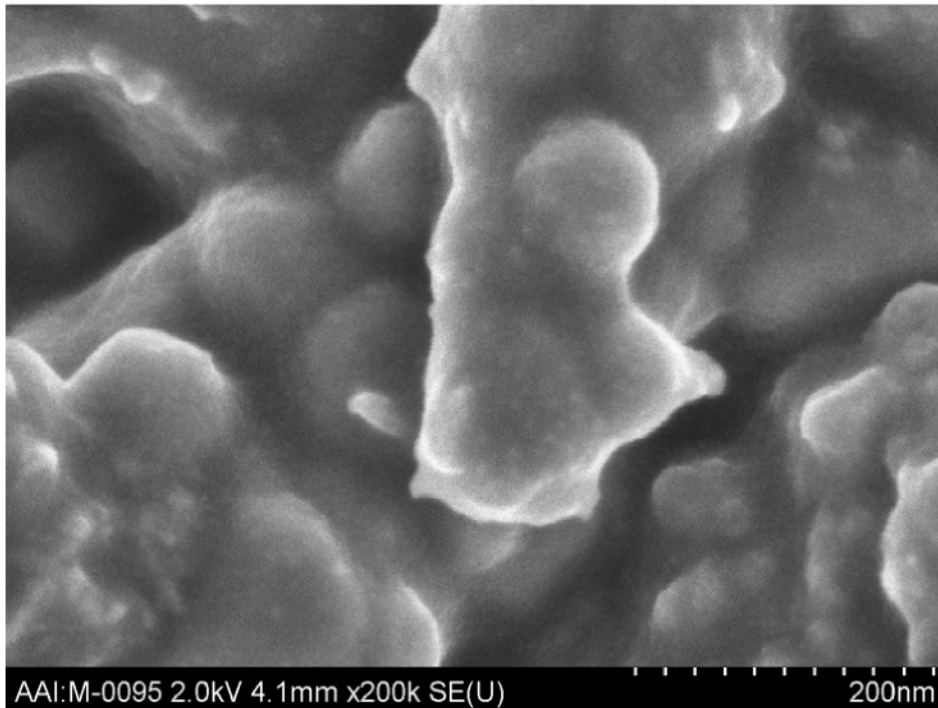
M-05 100,000X

A secondary electron image of a select region on the North Face TGA residue sample is shown.



M-06 200,000X

A secondary electron image of a select region on the North Face TGA residue sample is shown.



M-07 5,000X

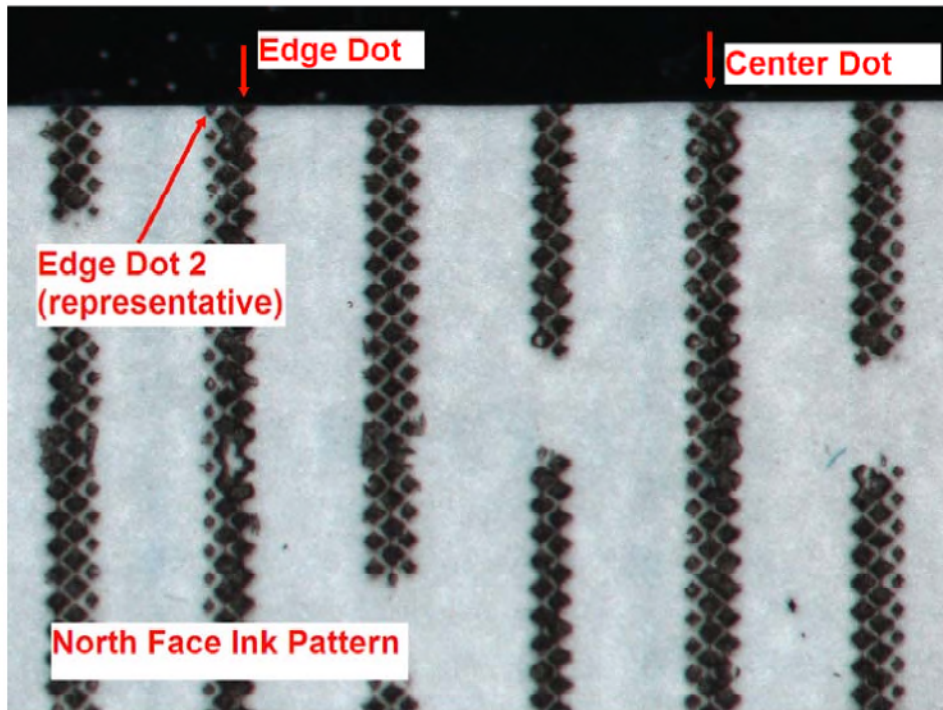
A secondary electron image of a select region on the North Face TGA residue sample is shown. EDS area analysis X-01 was obtained from the entire imaged region here.





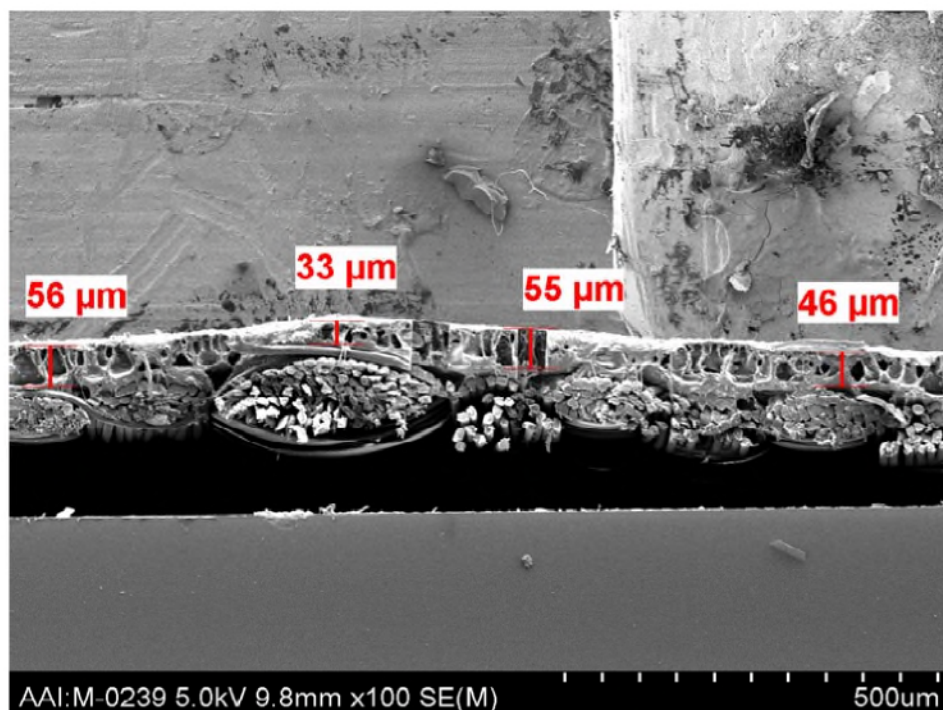
M-08 32X

Optical image showing the features of interest on the North Face sample.



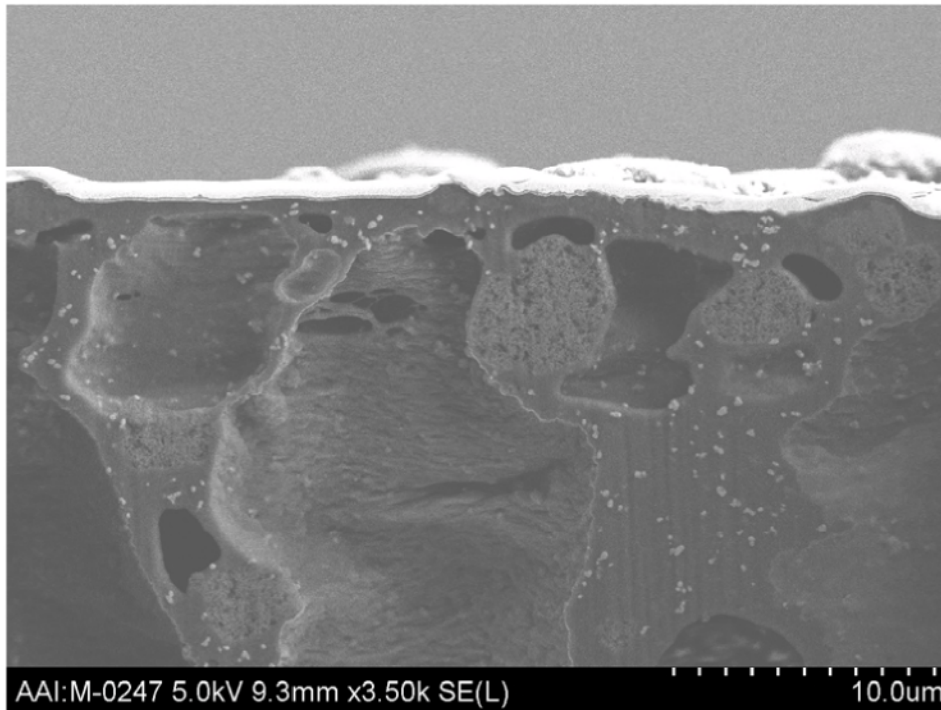
M-09 100X

Secondary electron image showing cross-sectional view of the North Face sample, with two FIB cut boxes in the field of view.



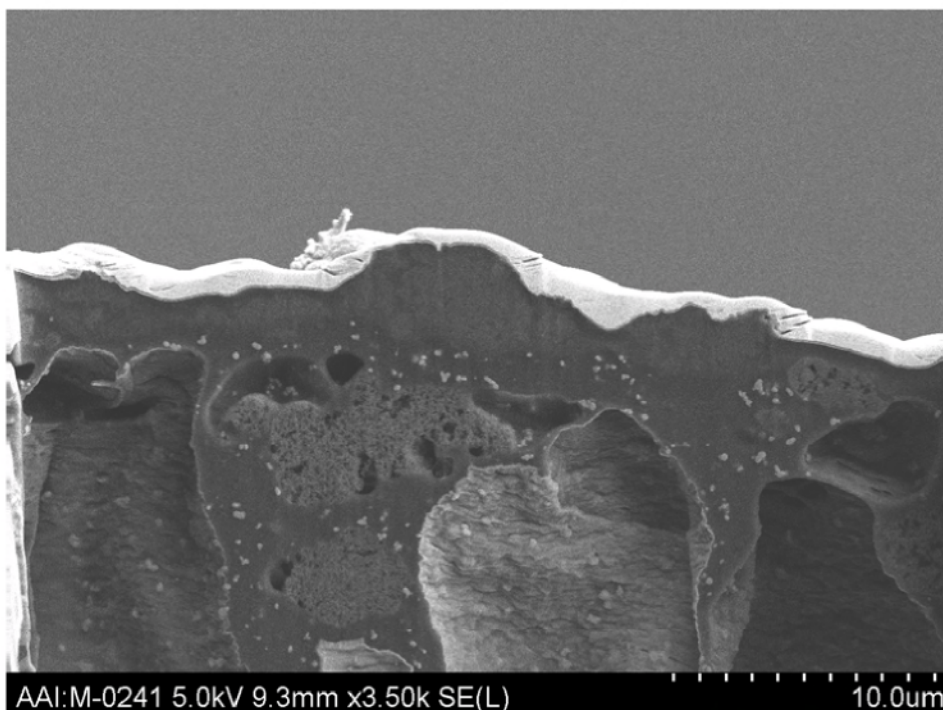
M-10 3,500X

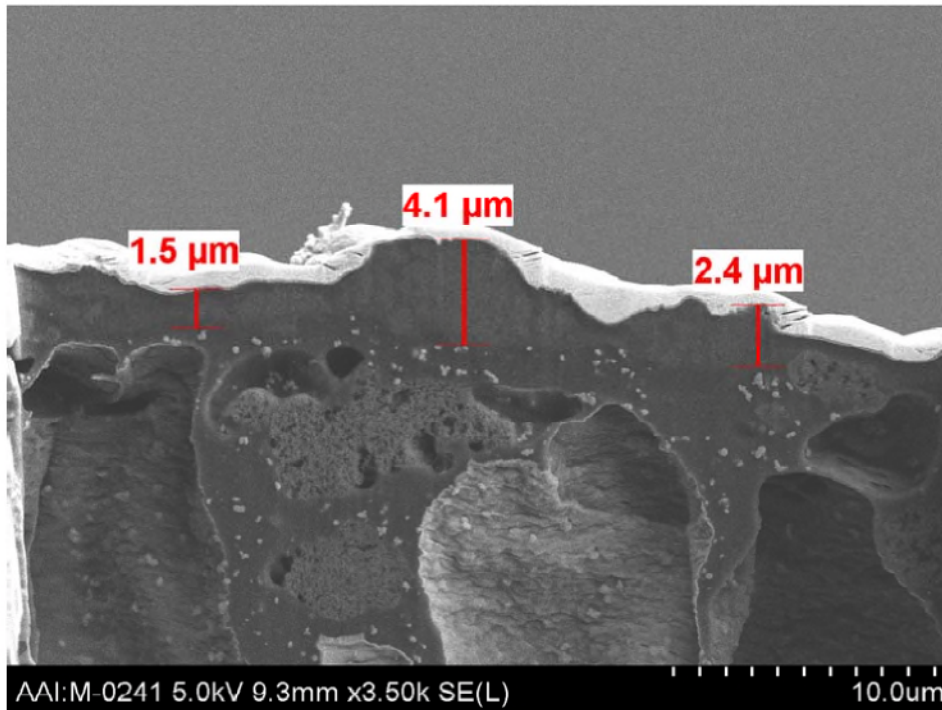
Secondary electron image showing ink-free (blank) area on the North Face sample.



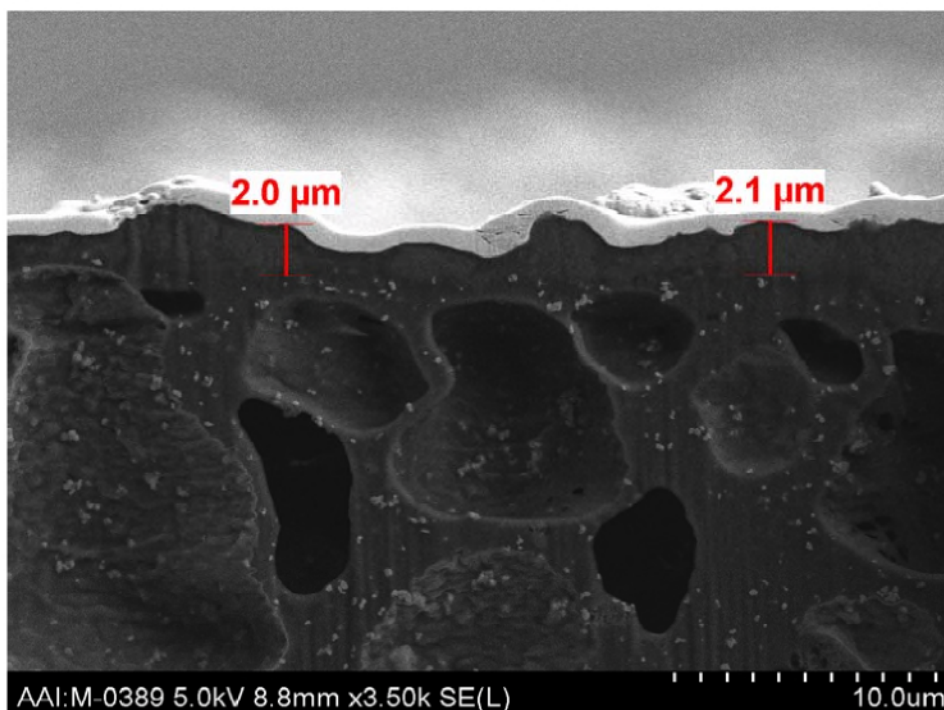
M-11 3,500X

Secondary electron image showing ink coated area on the North Face sample. Image obtained from the "Center" dot in the line pattern.



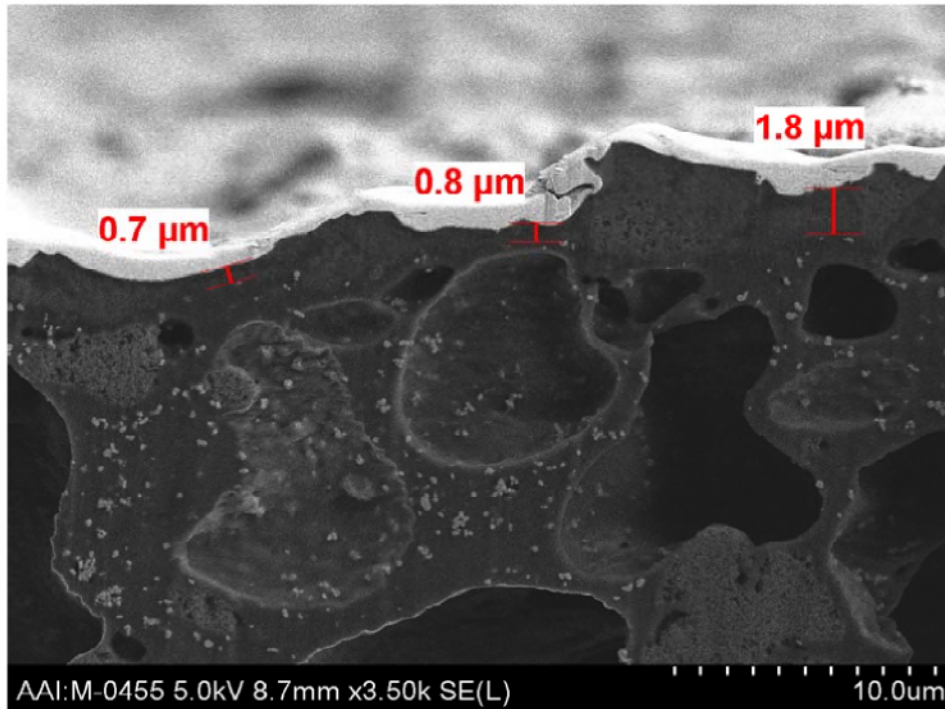


M-12 3,500X  
Secondary electron image showing the approximate thickness of ink coating in the "Center Dot" feature on the North Face sample.

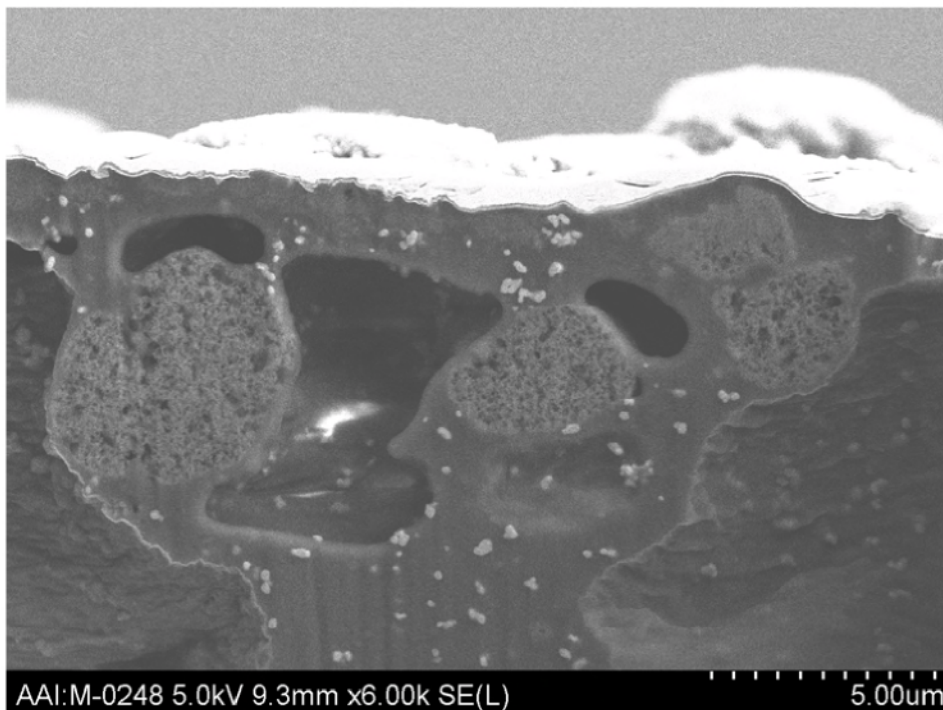


M-13 3,500X  
Secondary electron image showing the approximate thickness of ink coating in the "Right Edge Dot" feature on the North Face sample.

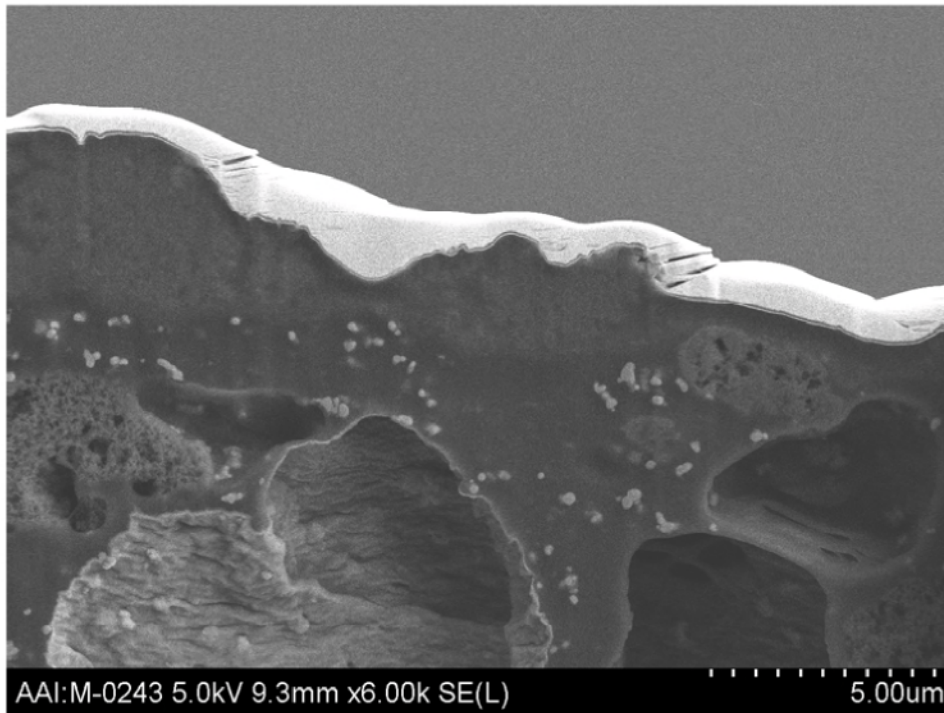




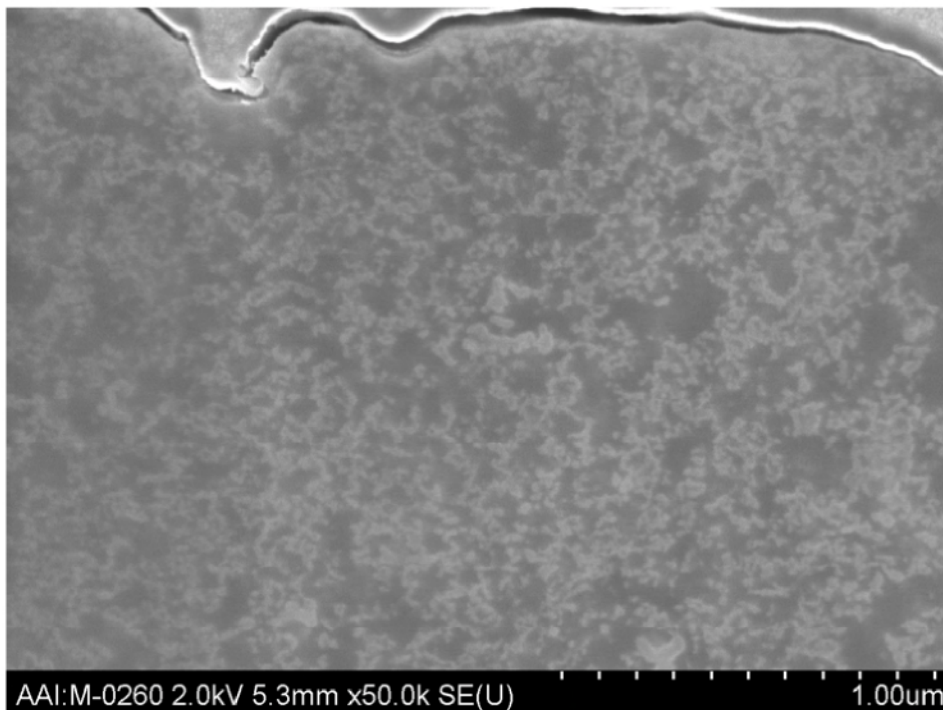
M-14 3,500X  
Secondary electron image showing the approximate thickness of ink coating in the "Left Edge Dot" feature on the North Face sample.



M-15 6,000X  
Secondary electron image obtained from ink-free (blank) area on the North Face sample.

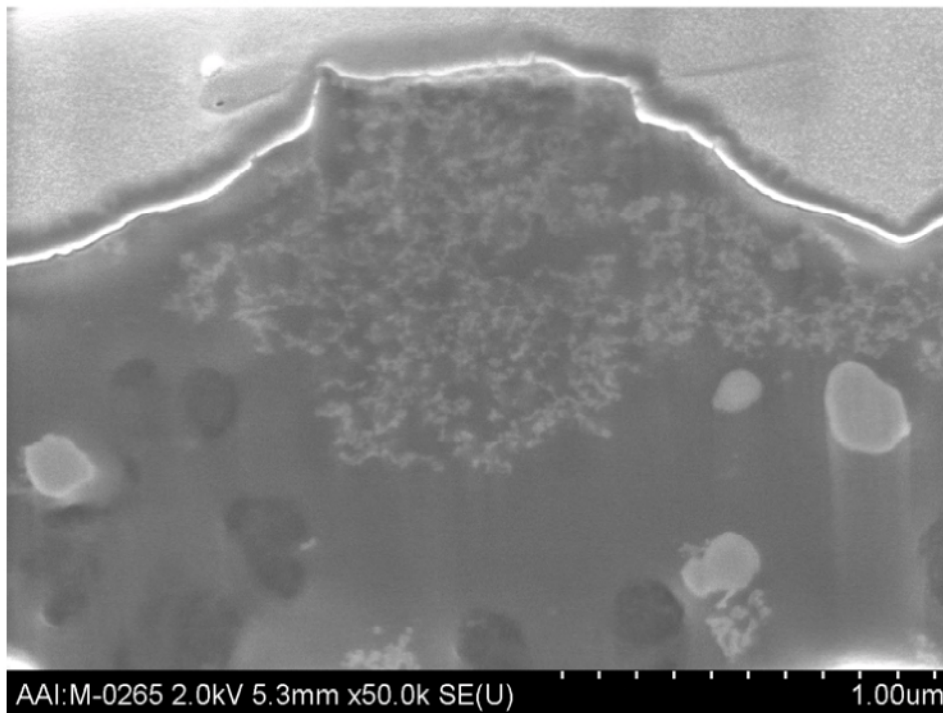


M-16 6,000X  
Secondary electron image  
from ink coated area on the  
North Face sample. Image  
obtained from the "Center"  
dot in the line pattern.

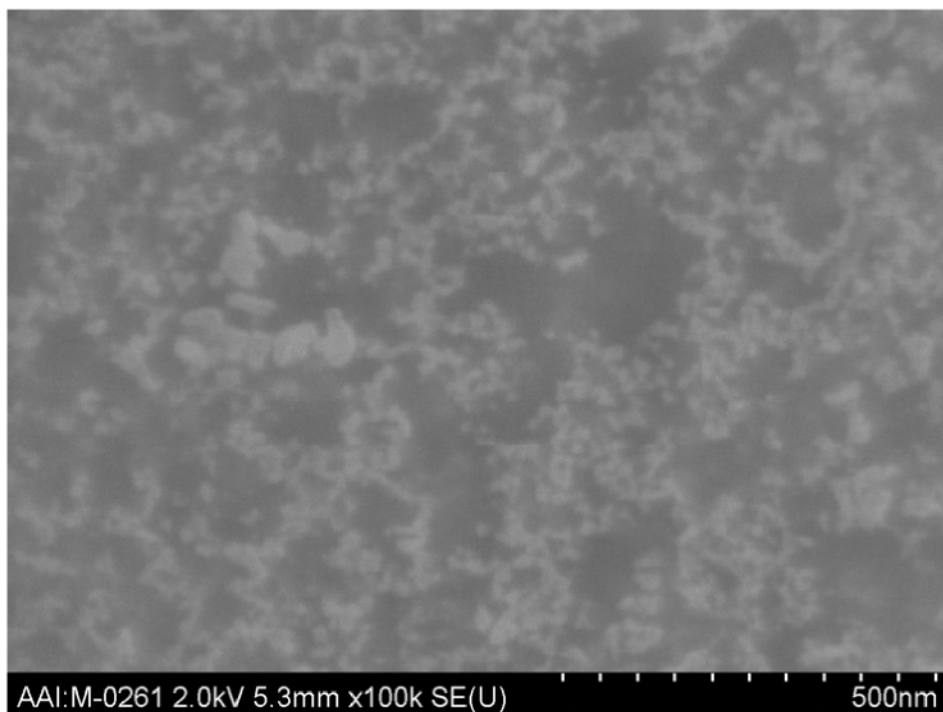


M-17 50,000X  
Secondary electron image  
from ink coated area on the  
North Face sample. Image  
obtained from the "Center"  
dot in the line pattern.

M-18 50,000X  
Secondary electron image  
from ink free area on the  
North Face sample.



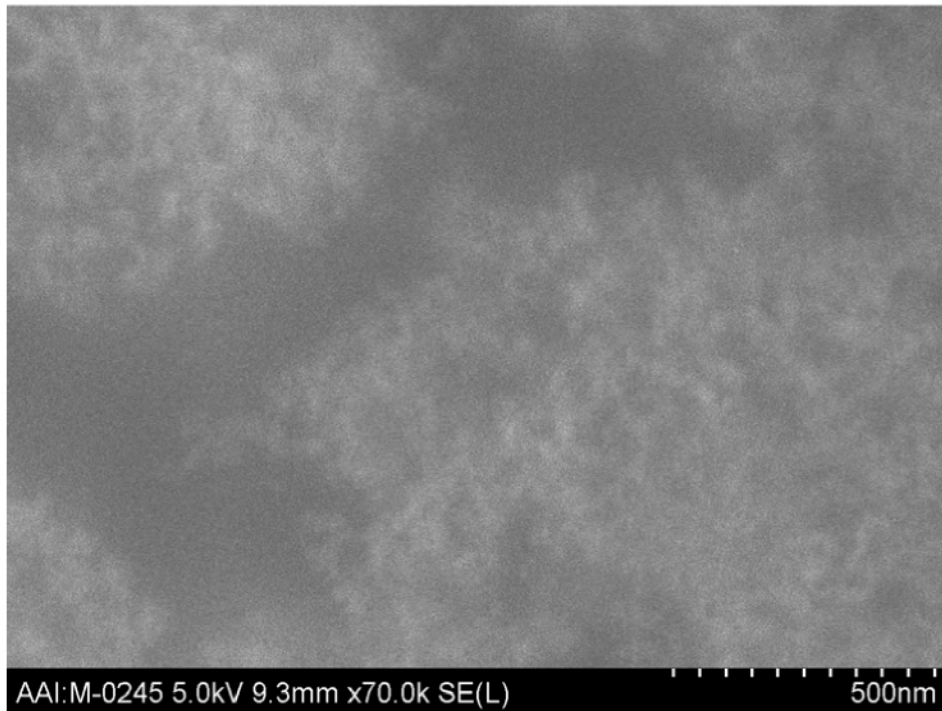
M-19 100,000X  
Secondary electron image  
from ink coated area on the  
North Face sample. Image  
obtained from the "Center"  
dot in the line pattern.





M-20 70,000X

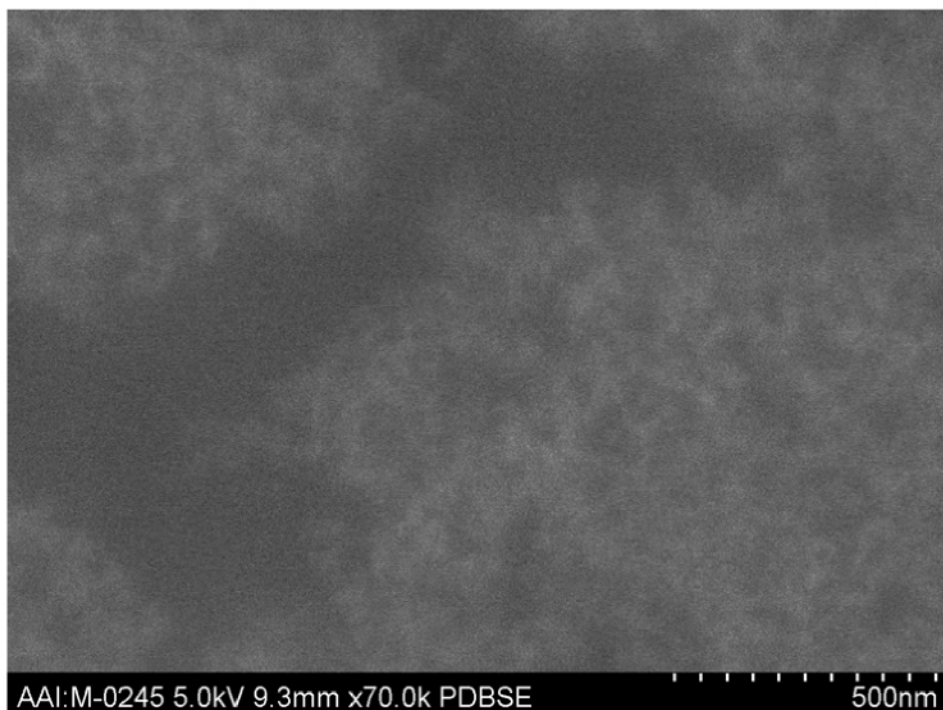
Secondary electron image from ink coated area on the North Face sample. Image obtained from the "Center" dot in the line pattern.



M-21 70,000X

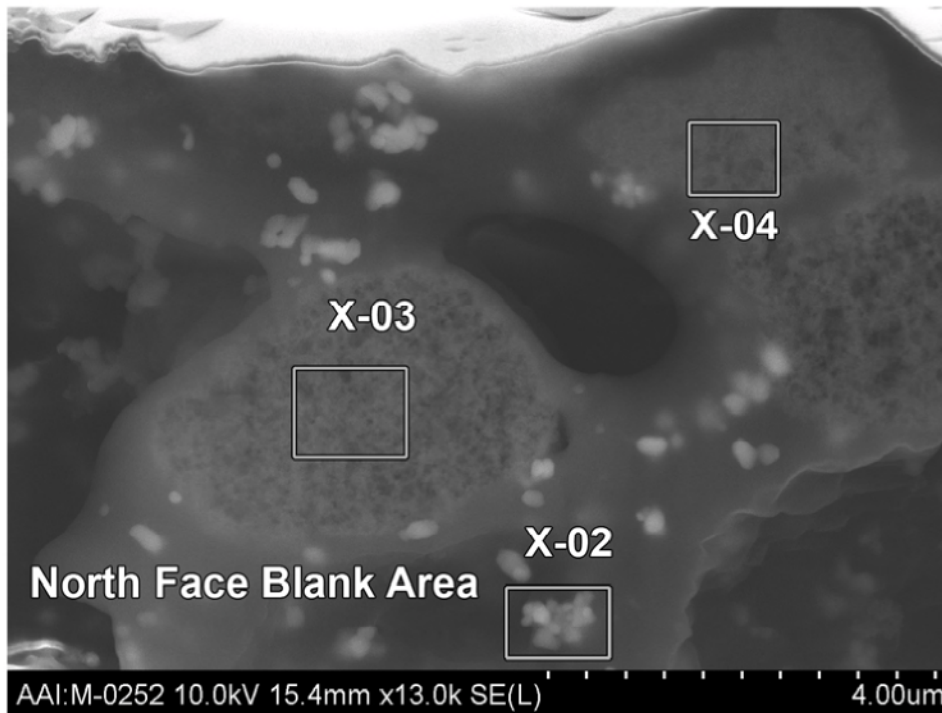
Backscattered electron (BSE) image from same field of view as image M-20 (above).

BSE image contrast is effected by average atomic mass so brighter contrast indicates heavier material.



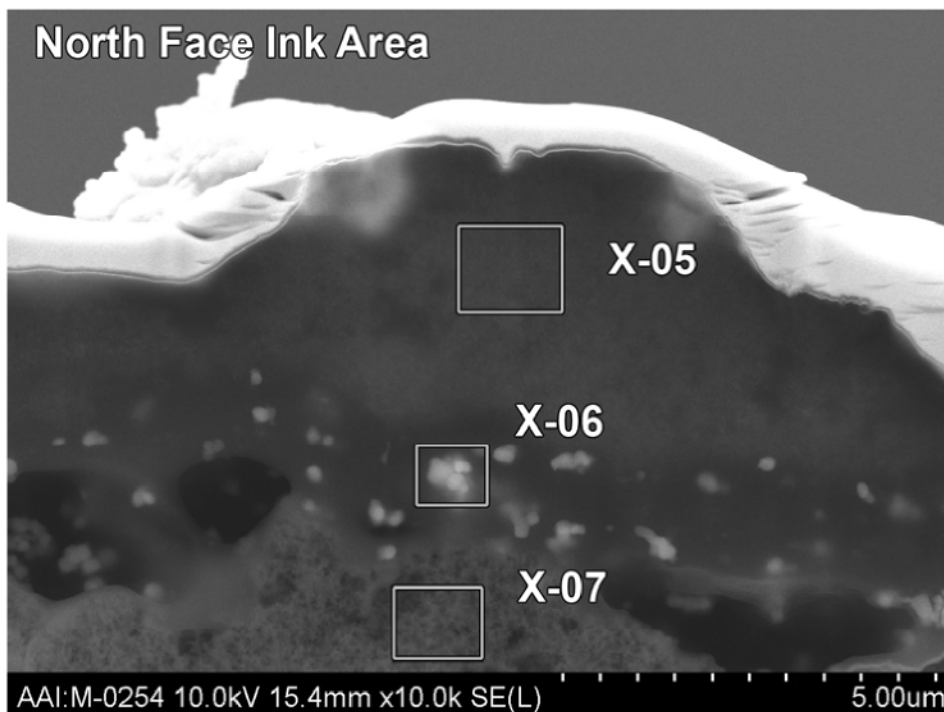
M-22 13,000X

Secondary electron image showing location of EDS spectra acquired from ink free area of the North Face sample.

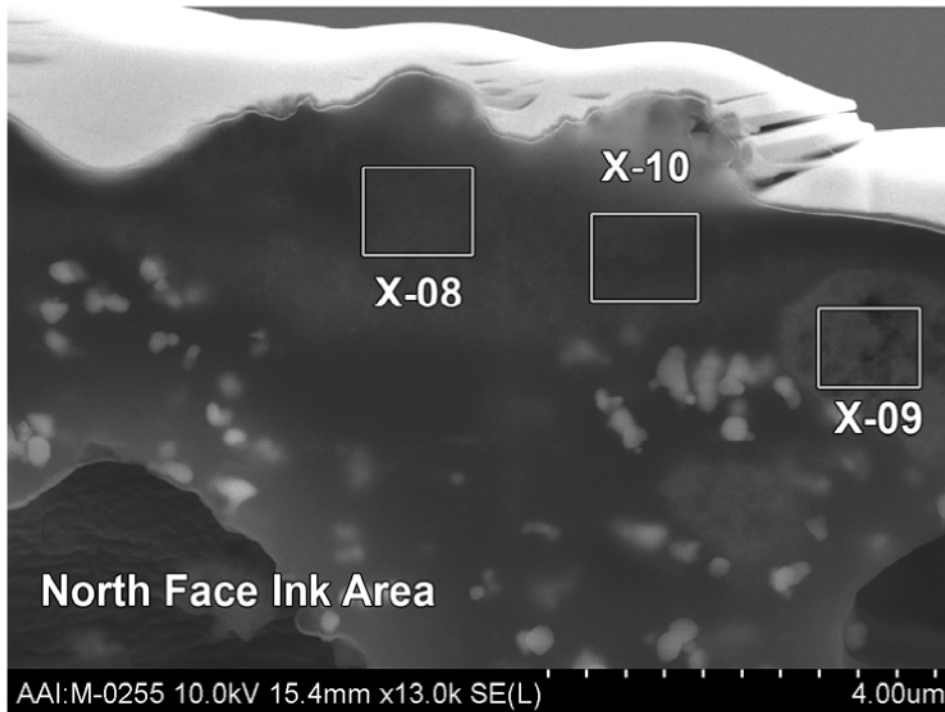


M-23 10,000X

Secondary electron image showing location of EDS spectra acquired from ink coated area of the North Face sample ("Center Dot" area).

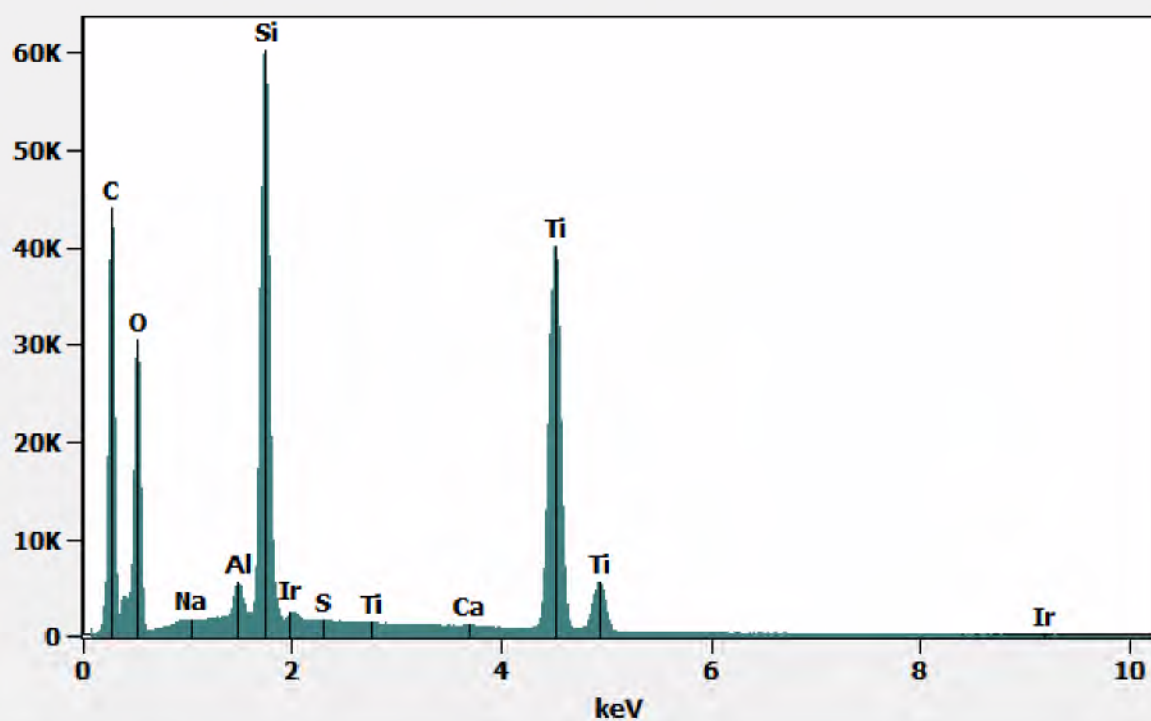


M-24 13,000X  
Secondary electron image  
showing location of EDS  
spectra acquired from ink  
coated area of the North Face  
sample ("Center" Dot Area).



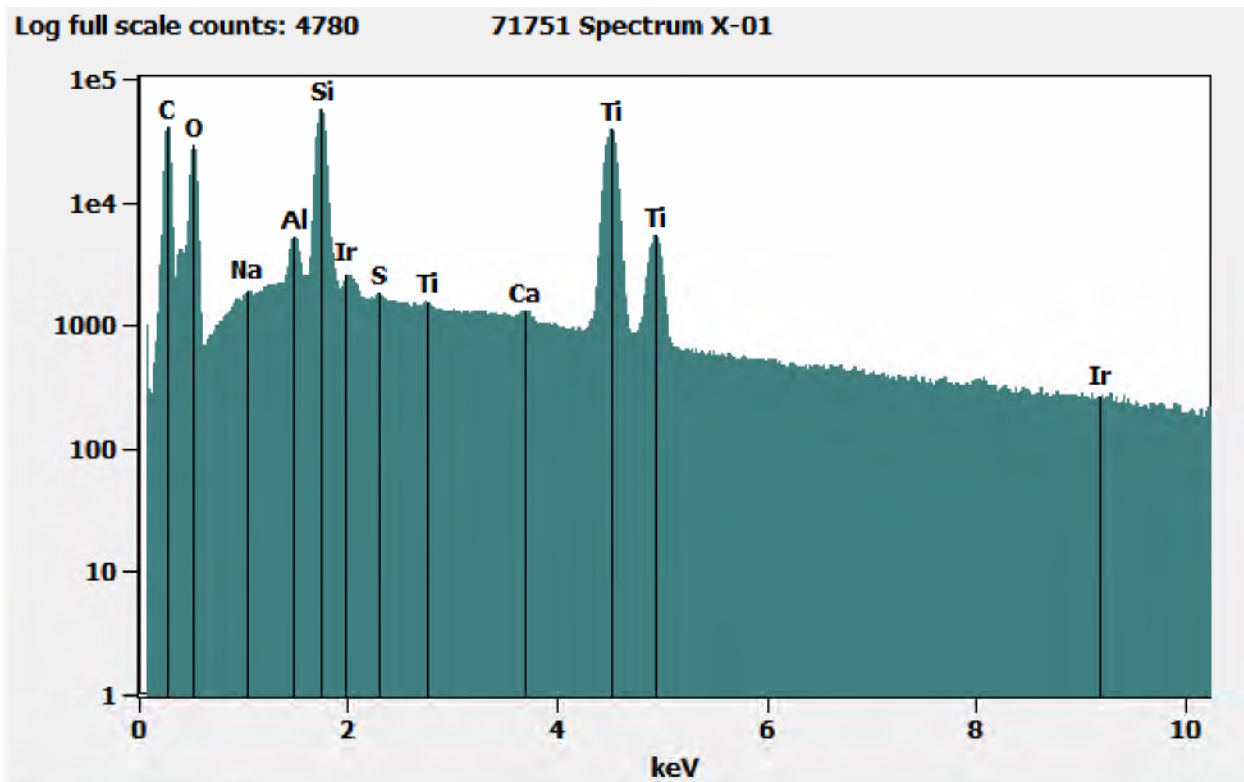
Full scale counts: 60389

71751 Spectrum X-01



71751 Spectrum X-01  
North Face TGA Residue  
Area Analysis

1nm of iridium was applied to the sample prior to analysis.

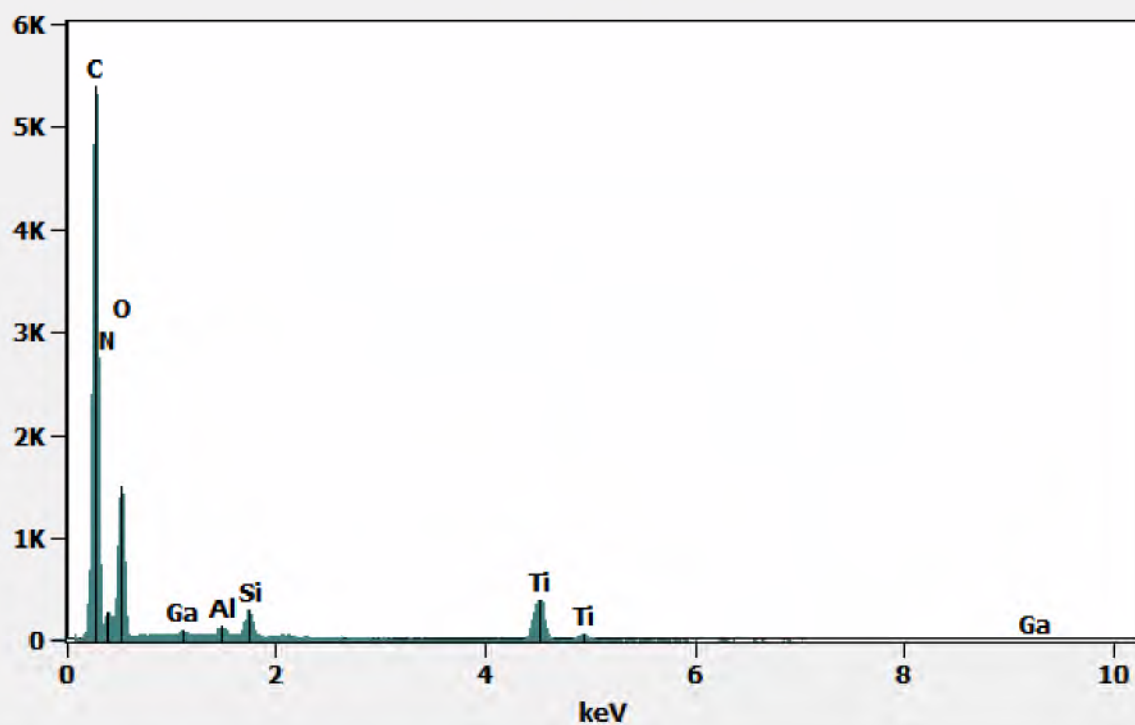


71751 Spectrum X-01  
North Face TGA Residue  
Area Analysis

1nm of iridium was applied to the sample prior to analysis.

Full scale counts: 5401

71751 Spectrum X-02



71751 Spectrum X-02

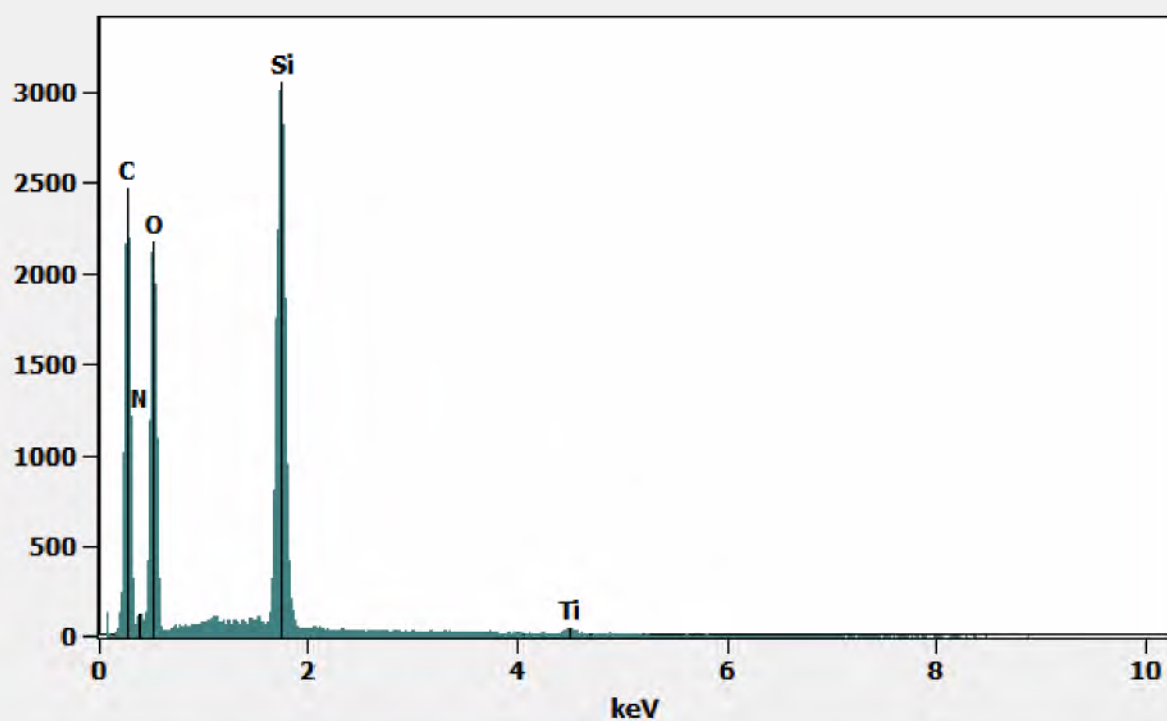
North Face Blank area; small bright particles

Pt and/or Ga are due to FIB prep



Full scale counts: 3056

71751 Spectrum X-03

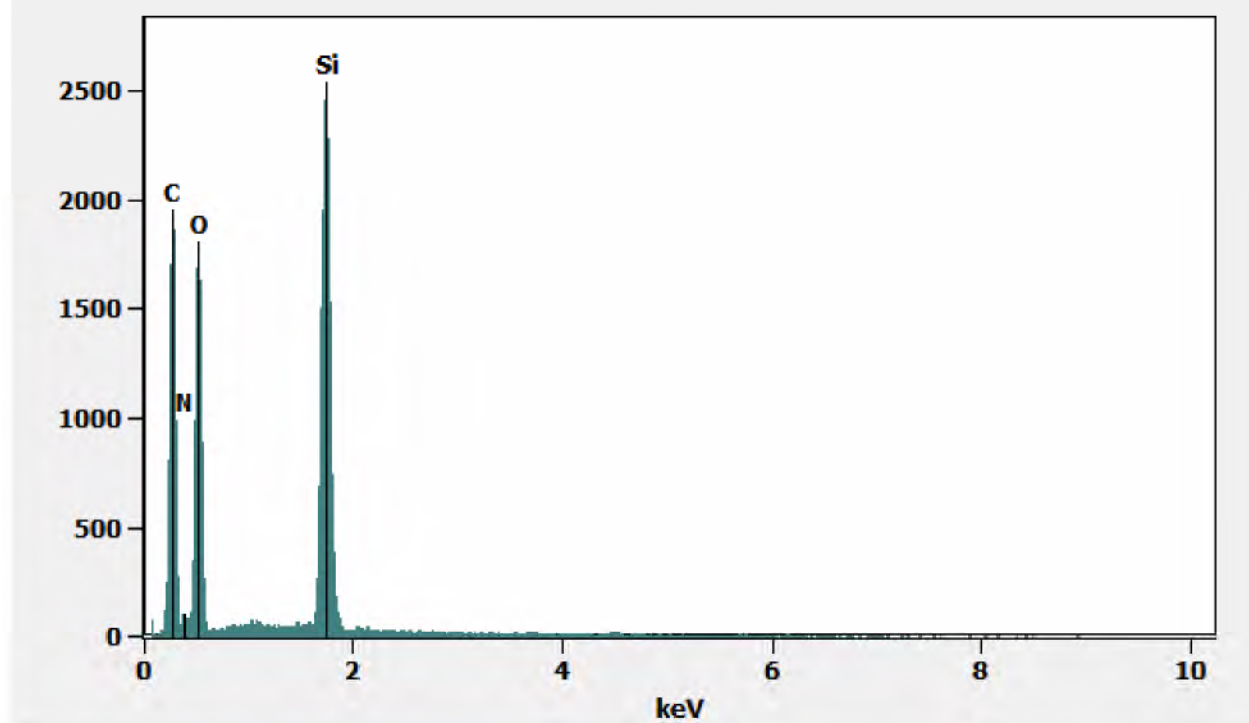


71751 Spectrum X-03

North Face Blank area; porous particle

Full scale counts: 2542

71751 Spectrum X-04

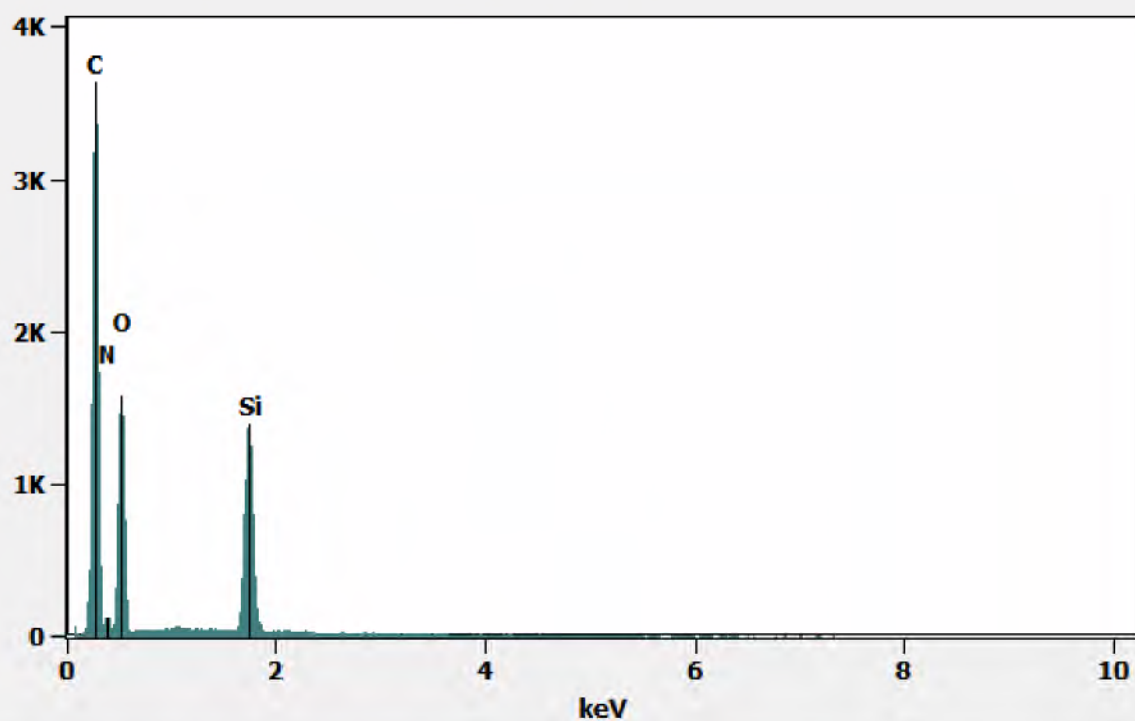


71751 Spectrum X-04

North Face Blank area; porous particle

Full scale counts: 3643

71751 Spectrum X-05

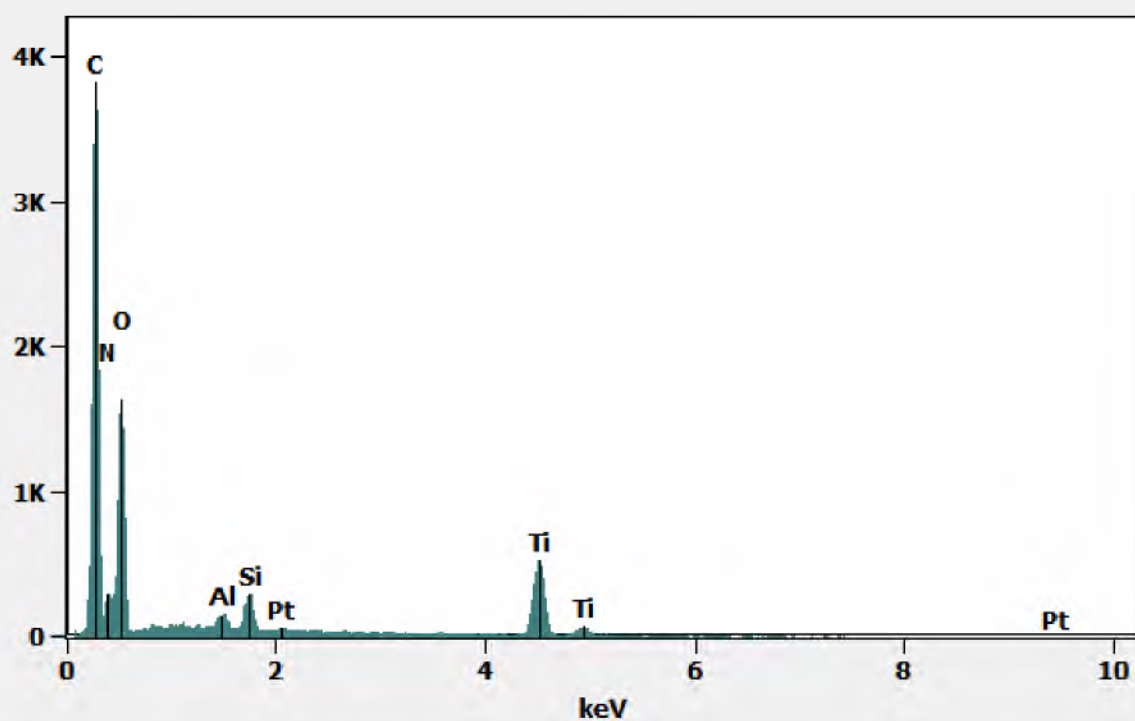


71751 Spectrum X-05

North Face Ink area; Ink area at top

Full scale counts: 3834

71751 Spectrum X-06



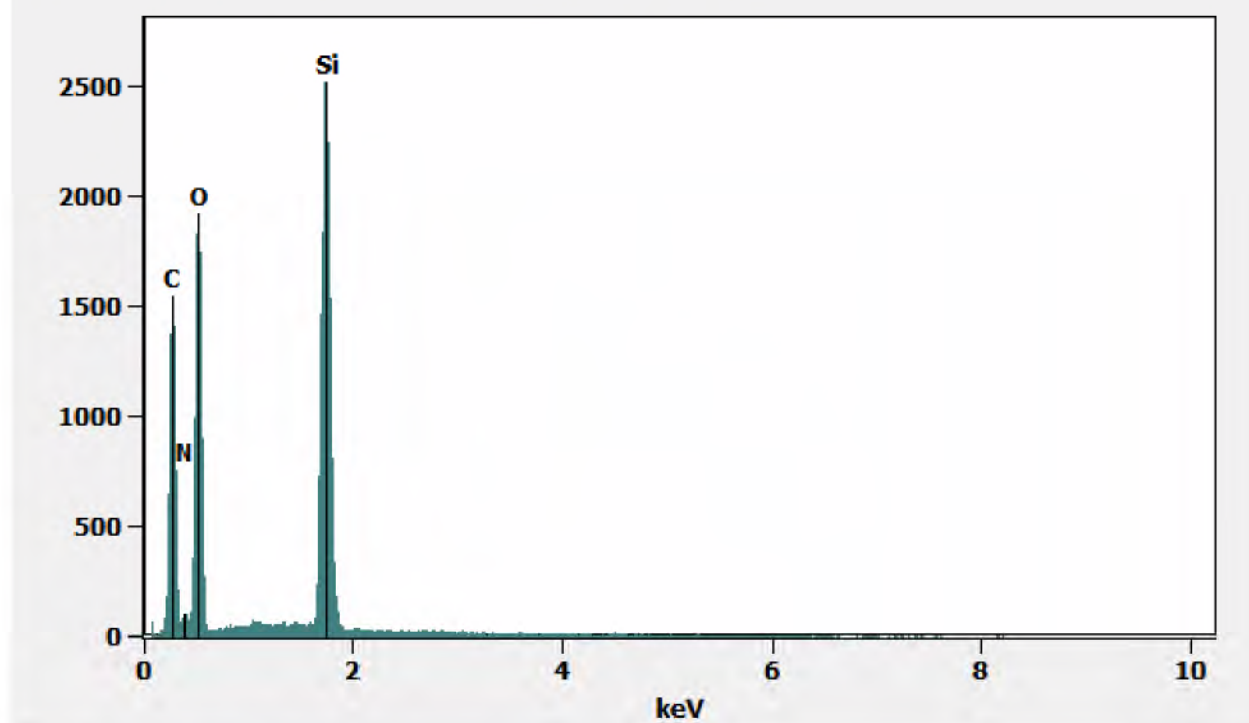
71751 Spectrum X-06

North Face Dot area; small bright particles

Pt and/or Ga are due to FIB prep

Full scale counts: 2521

71751 Spectrum X-07

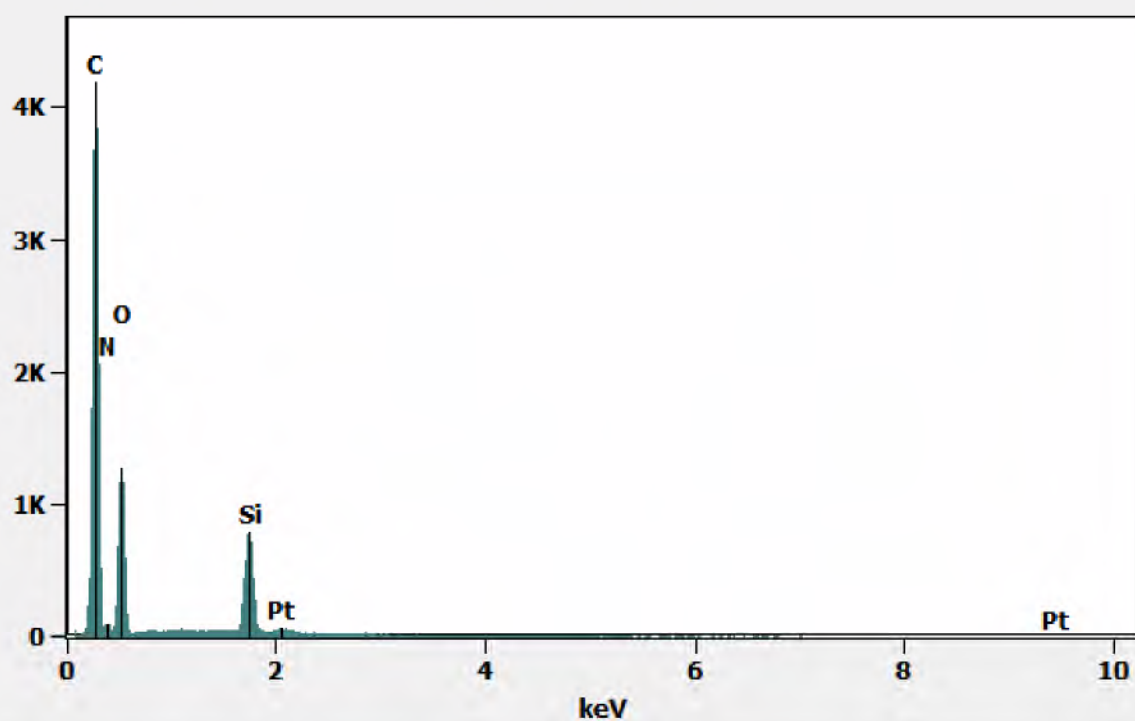


71751 Spectrum X-07

North Face Dot area; porous particle

Full scale counts: 4192

71751 Spectrum X-08



71751 Spectrum X-08

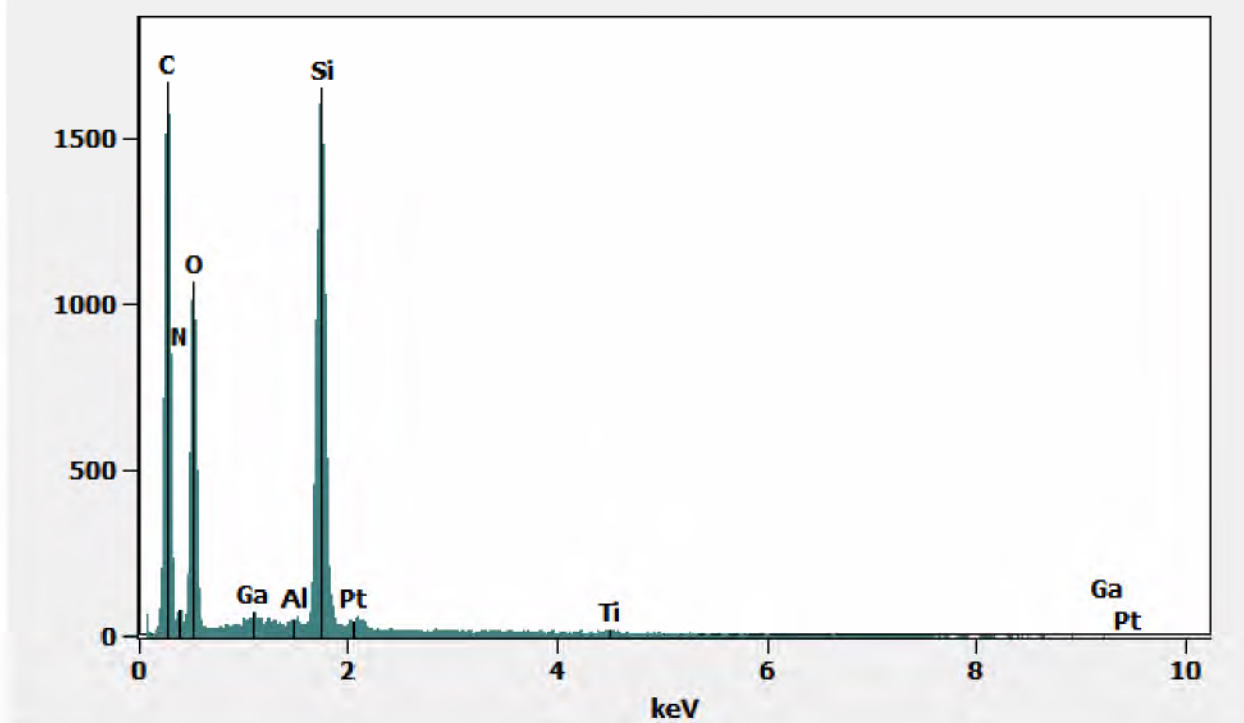
North Face Dot area; Ink region near top

Pt and/or Ga are due to FIB prep



Full scale counts: 1674

71751 Spectrum X-09



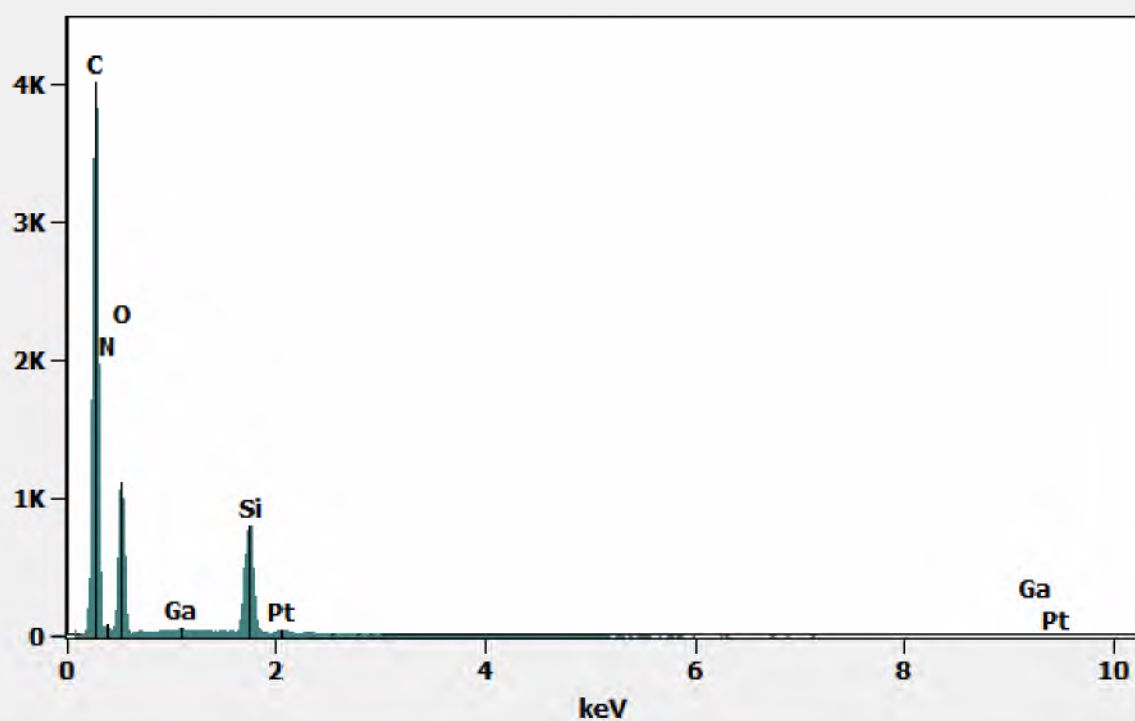
71751 Spectrum X-09

North Face Dot area; porous particle near top

Pt and/or Ga are due to FIB prep

Full scale counts: 4016

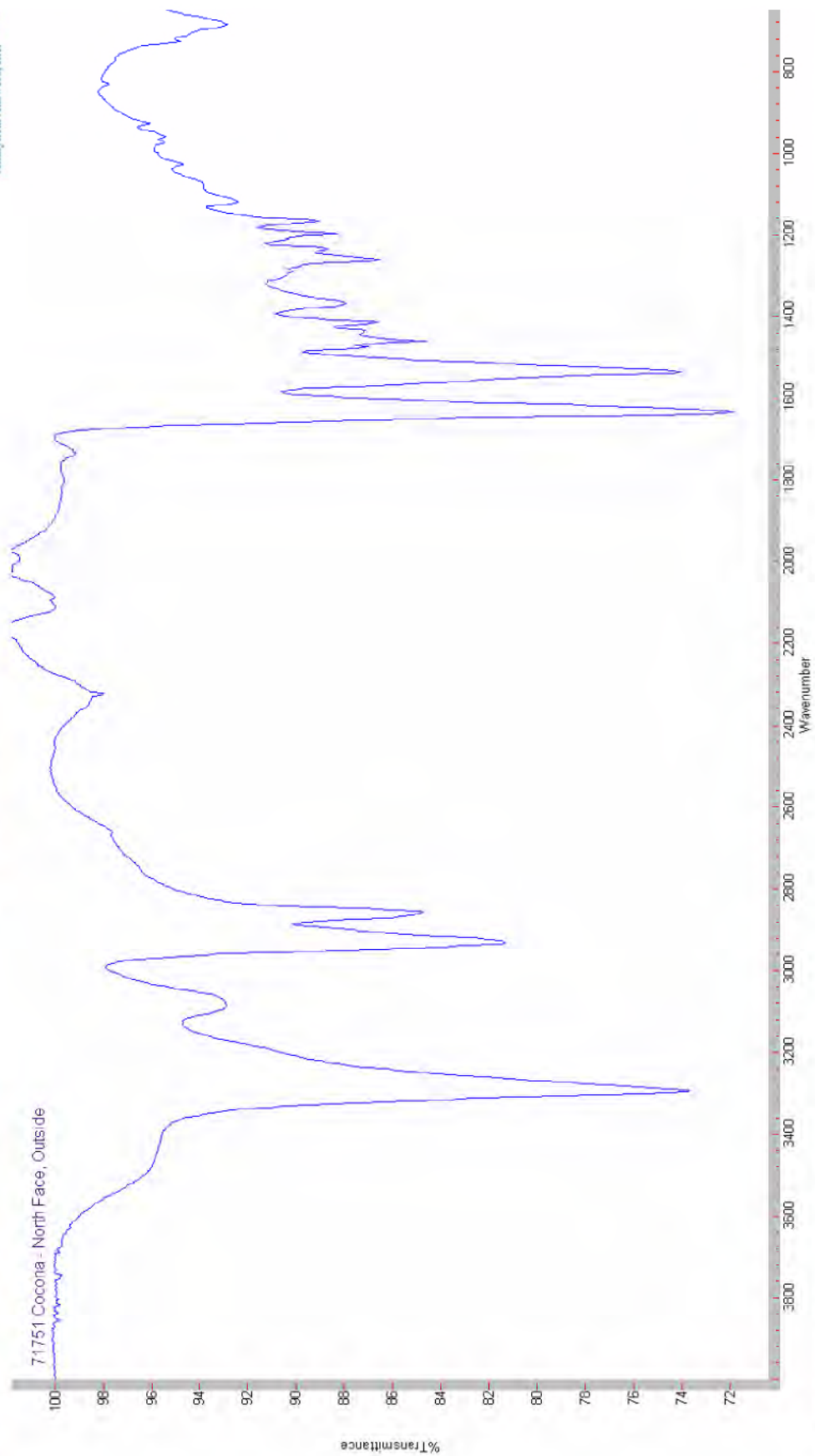
71751 Spectrum X-10



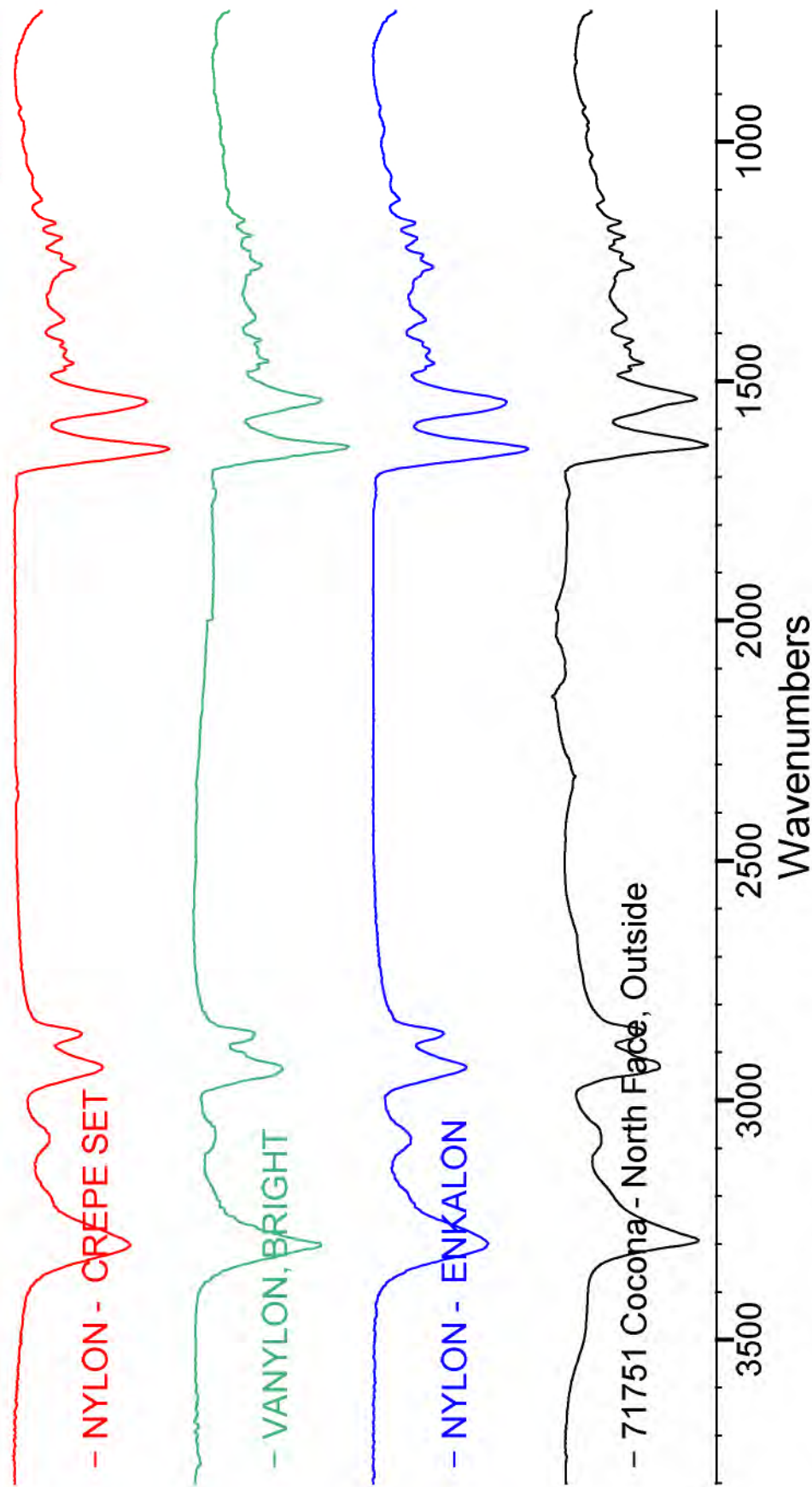
71751 Spectrum X-10

North Face Dot area; dark region near top

Pt and/or Ga are due to FIB prep

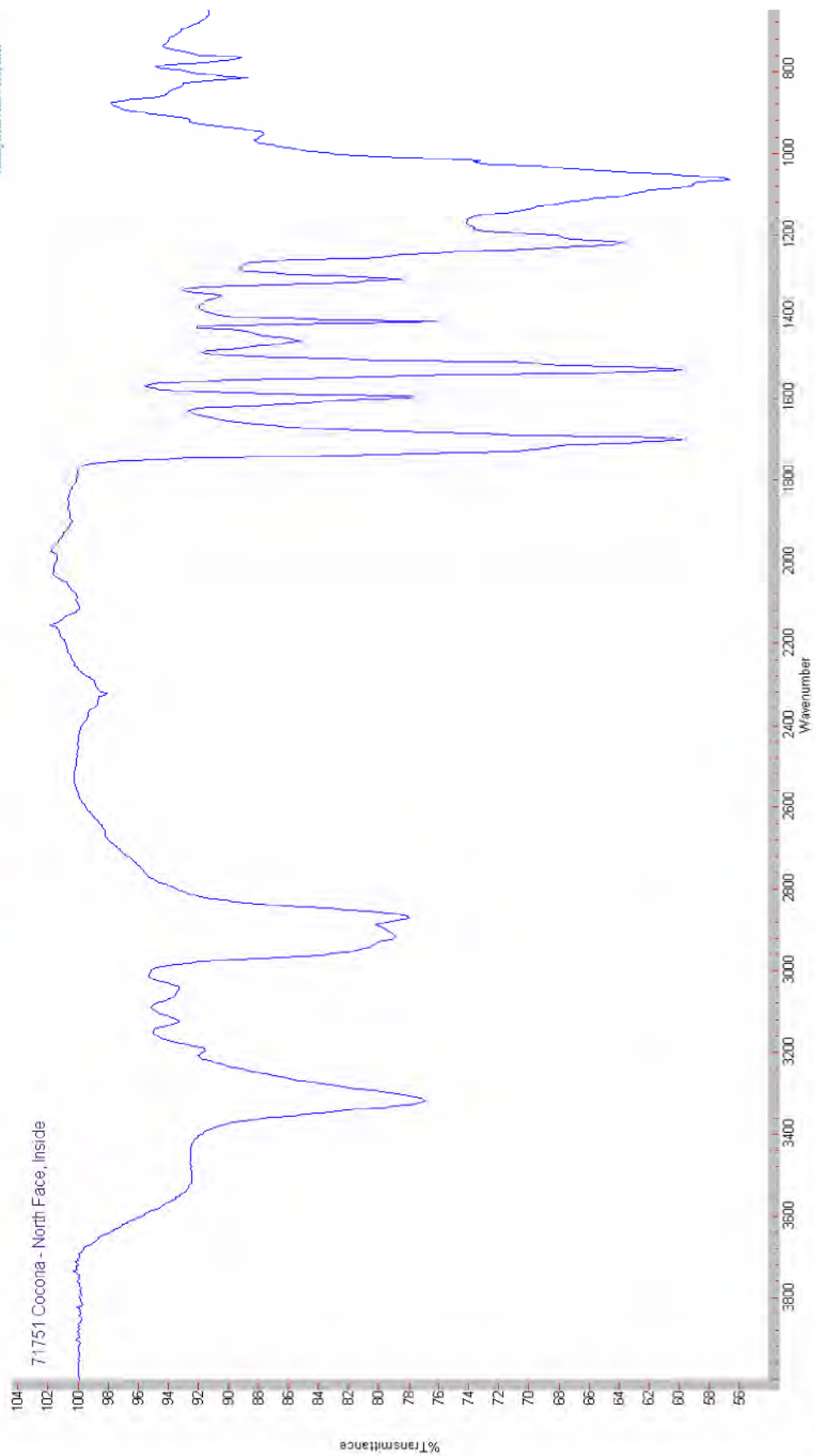


71751 Cocona - North Face, Outside - Nylon 6

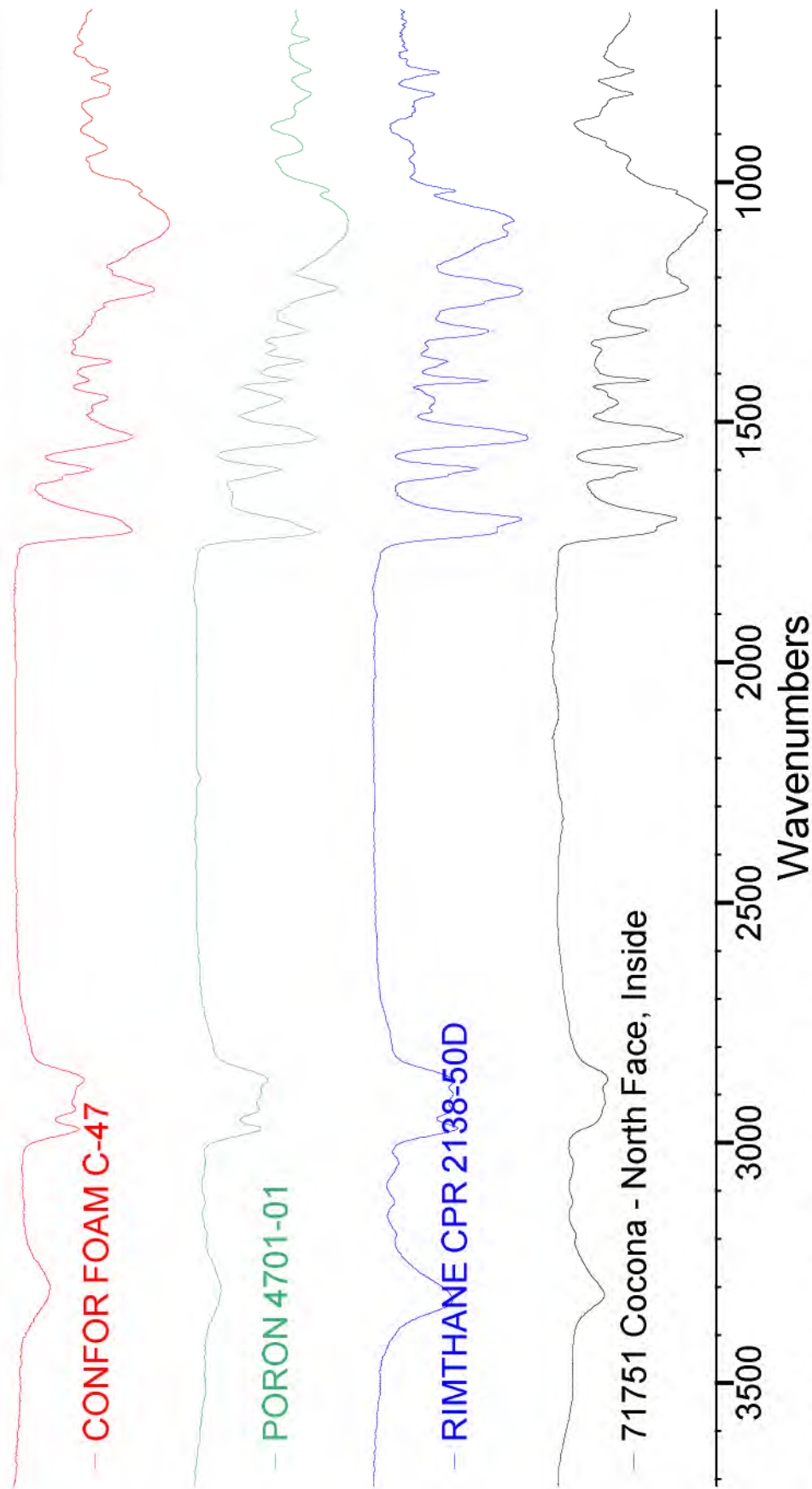


71751 Cocona - North Face, Outside, compared to representative commercial Nylon 6 (PA-6) fibers.

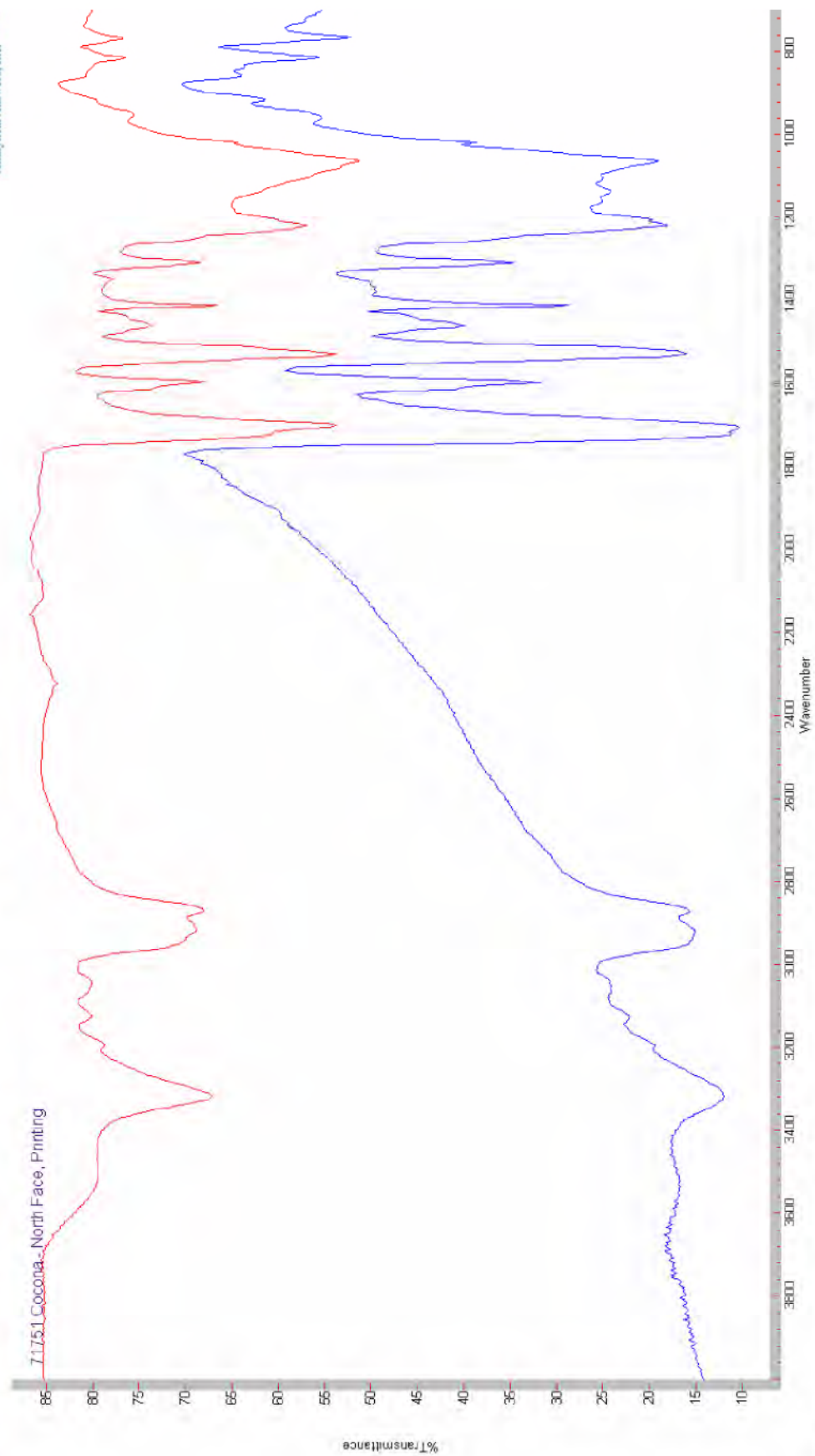




71751 Cocona - North Face, Inside - Polyether-based Polyurethane



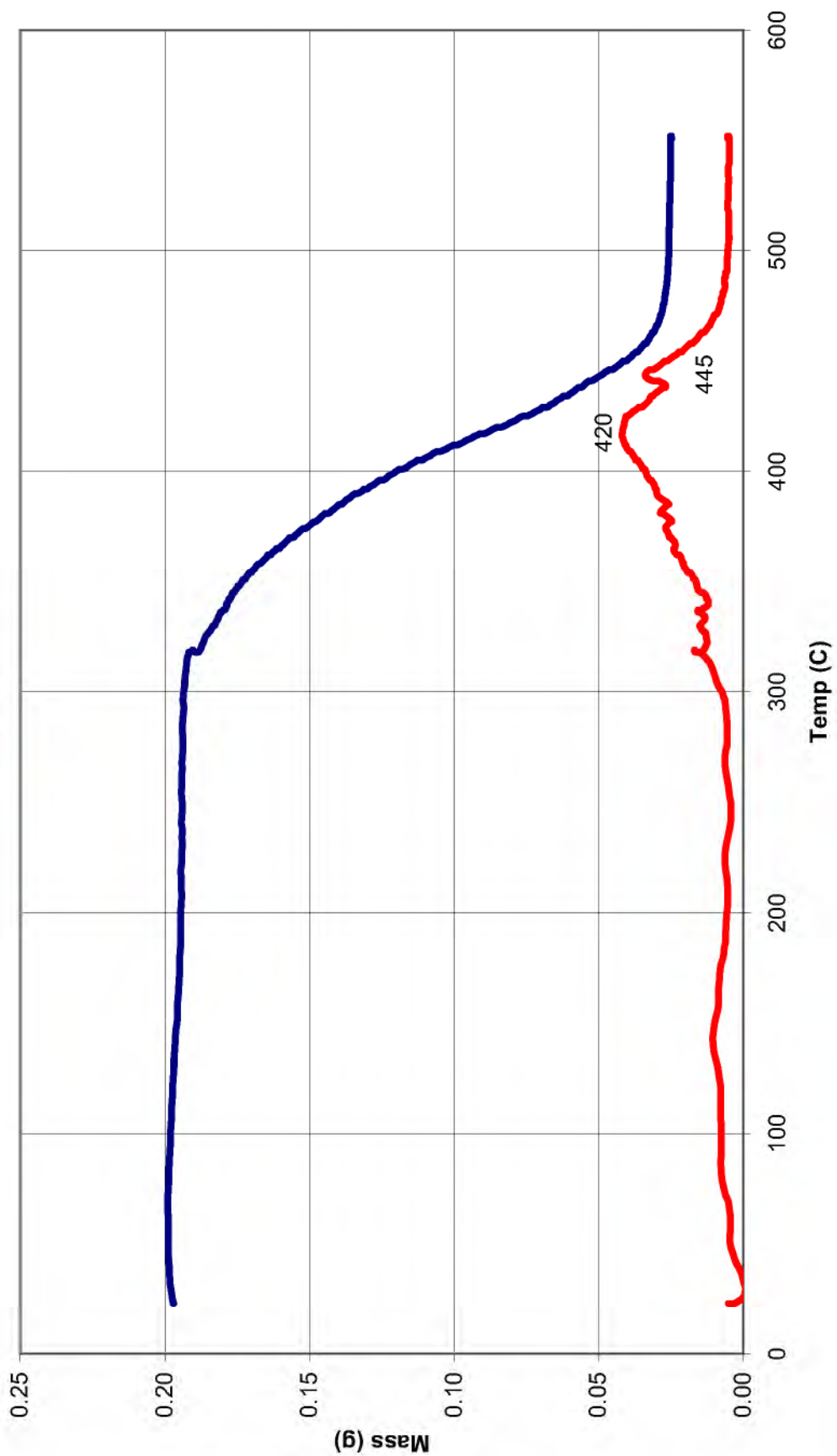
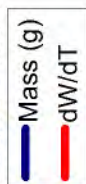
71751 Cocona - North Face, Inside, compared to representative commercial polyether-based polyurethane resins.



71751 Cocona - North Face, Printing (blue), compared to North Face Inside (top, red). Baseline offset and tilt from infrared scattering materials (carbon black, black metal oxides and/or sulfides, etc.). Also note broad ~1050 band, suggesting additional silica or silicates. Please see EDS results for elemental characterization.



**AAI TGA**  
**71751 Cocona - North Face**







A Report

to

**Cocona, Inc.**

on

**Total Heat Loss Measurements of Five Materials**

from

Center for Research on Textile Protection and Comfort (T-PACC)  
College of Textiles  
North Carolina State University  
Raleigh, North Carolina 27695-8301

August 2012

## **Total Heat Loss Measurements of Five Materials**

Five samples were submitted to the Textile Protection and Comfort Center (TPACC) in the College of Textiles at North Carolina State University, for characterization of the heat transport properties that contribute to thermal comfort. The purpose of this report is to describe the test method used to characterize these materials and to present the results of the laboratory test.

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### **Test Materials**

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The test sample consisted of five fabric samples. The samples are identified as **A, B, C, G** and **H** for this report.

#### **Legend**

**A= DF241153 (knitted, tested as received)**

**B= DF241151 (knitted, as received)**

**C= DF241152 (knitted, as received)**

**G= Laminated (Hydrophobic Film + Treatment)**

**H= Laminated (Hydrophobic Film)**

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## Test Method

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The heat and moisture transfer properties determined in this program were calculated from measurements of thermal transport made with the large skin model hot plate instrumentation. Samples were tested in accordance with the procedures of ASTM F 1868, Standard Test Method for Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate, Part C. A description of the measured heat transfer parameters is given below; other details pertaining to instrumentation, methods and calculations are given in Appendix A.

### Dry and Sweating Skin Tests

The measurement of heat transfer is a measure of heat flow from the calibrated test plate (heated to a skin surface temperature of 35°C) through the composite into the test environment (25°C, 65%RH), and is determined for both simulated dry and wet skin conditions. Heat loss parameters, calculated from thermal transport measurements, are listed below.

- a. **Total Thermal Resistance ( $R_{ct}$ )**,  $[(\Delta^{\circ}\text{C})(\text{m}^2)/\text{W}]$ , the total resistance to dry heat transfer (insulation) for a fabric system including the surface air layer.
- b. **Intrinsic Thermal Resistance ( $R_{cf}$ )**,  $[(\Delta^{\circ}\text{C})(\text{m}^2)/\text{W}]$ , the resistance to dry heat transfer provided by the fabric system alone.
- c. **Bare Plate Thermal Resistance ( $R_{cbp}$ )**,  $[(\Delta^{\circ}\text{C})(\text{m}^2)/\text{W}]$ , the resistance to dry heat provided by the surface air layer as measured on the bare plate.
- d. **Apparent Total Evaporative Resistance ( $R_{et}^A$ )**,  $[(\Delta\text{kPa})(\text{m}^2)/\text{W}]$ , the total resistance to evaporative heat transfer for a fabric system including the surface air layer and liquid barrier (the descriptor term ‘apparent’ is added to account for the fact that heat transfer may have an added condensation component in non-isothermal conditions).
- e. **Apparent Intrinsic Evaporative Resistance ( $R_{ef}^A$ )**,  $[(\Delta\text{kPa})(\text{m}^2)/\text{W}]$ , the resistance to evaporative heat transfer provided by the fabric system alone.
- f. **Bare Plate Thermal Resistance ( $R_{epb}$ )**,  $[(\Delta\text{kPa})(\text{m}^2)/\text{W}]$ , the resistance to evaporative heat transfer provided by the liquid barrier and surface air layer as measured on the bare plate (with liquid barrier attached).
- g. **Total Heat Loss ( $Q_t$ )**,  $[\text{W}/\text{m}^2]$ , an indicator of the heat transferred through the test material by the combined dry and evaporative heat loss, from a fully sweating test plate surface into the test environment. Total heat loss, measured at a 100% wet skin condition, indicates the highest predicted metabolic activity level that a wearer may sustain and still maintain body thermal comfort while in a highly stressed state in the test environment. For reference, Appendix C contains a table of the metabolic rates for various activities. Note, however, that the sweating hot

plate does not consider effects such as insulating air layers, garment design, and fit. Thus, the Total Heat Loss value obtained represents the highest theoretically possible amount of heat that can be transferred through a material system for a given set of environmental conditions without active cooling or ventilation.

- h.  **$I_t$** , [clo], indicates the thermal resistance measured in units of clo which indicates the insulating ability of the test material. Materials having higher clo values provide wearers with more thermal insulation and consequently greater heat storage during exertion. A clo value of 1 represents a typical men's business suit and is expected to maintain thermal comfort for a person in a normal indoor environment. Requirements vary from about 0.5 clo for summer wear to 4 to 5 clo for outdoor winter clothing. This value includes the insulation provided by the air layer above the sample and doesn't subtract it out as with  $R_{cf}$ .
- i. The  **$i_m$  value**, or permeability index, indicates moisture-heat permeability through the material on a scale of 0 (totally impermeable) to 1 (totally permeable) normalized for the permeability of still air (naked skin). This comfort parameter indicates the effect of skin moisture on heat loss as in the case of a sweating skin condition. This value includes the evaporative resistance provided by the air layer above the sample and doesn't subtract it out as with  $R_{ef}^A$ .

## Weight

Weight is measured according to ASTM D 3776 small swatch option. Specimens (20 x 20 inch) were weighed on an analytical balance and the weight was calculated in mass per unit area (oz/yd<sup>2</sup>).



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## Test Results

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The average values for  $R_{ct}$ ,  $R_{et}^A$ ,  $R_{cf}$ ,  $R_{ef}^A$ ,  $I_t$ ,  $i_m$ , and  $Q_t$  of the samples received are contained in Table 1. Bare plate values are shown in Table 2. Weights are given in Table 3. Individual results of each test sample are displayed in Appendix B. All specimens were free from any significant creases in the test area.

Table 1: Sample Results from Sweating Hot Plate

Sample	$R_{ct}$	$R_{et}^A$	$R_{cf}$	$R_{ef}^A$	$I_t$	$I_m$	$Q_t$
A	0.082	0.00713	0.012	0.00146	0.529	0.690	912.90
B	0.084	0.00723	0.014	0.00156	0.542	0.698	891.55
C	0.084	0.00697	0.014	0.00129	0.542	0.724	930.03
G	0.094	0.00880	0.024	0.00313	0.606	0.641	694.77
H	0.093	0.00974	0.023	0.00407	0.600	0.574	631.27

Table 2: Bare Plate Test Results

Sample	$R_{cbp}$	$R_{ebp}$
Bare plate 1	0.070	0.005716
Bare plate 2	0.068	0.005741
Bare plate 3	0.069	0.005557
Average	<b>0.069</b>	<b>0.005671</b>

Table 3: Average Weights

Sample	Weight (oz/yd <sup>2</sup> )
A	3.45
B	3.51
C	3.19
G	3.56
H	3.40

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**Caveat**

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These data, obtained under controlled laboratory conditions, characterize the thermal resistance values of test sample responses to specific environmental conditions. These results should not be used to appraise the safety benefits or risks of the materials, products, or assemblies in extreme use conditions. The relationships between laboratory tests and field performance are not simple, and many things must be considered when making practical translations. Clothing comfort and heat stress performance are determined by many factors including material properties, garment design and fit, activity level, and the environmental conditions of use. These results do not address the full range of these issues. It is not our intention to recommend, exclude, or predict the suitability of any commercial product for a particular end use.

## Appendix A: Instrument, Methods, and the Calculation of Total Heat Loss Parameters

### Heat Transfer With/Without Moisture (Sweating Skin Condition)

Heat transfer makes it possible to predict the body heat that will flow from the skin surface through the material into the surrounding atmosphere. Heat and moisture transfer properties are key properties affecting clothing comfort. These thermal properties are analyzed using a guarded sweating hotplate system from Measurement Technology Northwest Inc. housed in an environmental test chamber set to achieve the required ambient conditions.

Tests were run in accordance with requirements of ASTM F 1868 Standard Test Method for Thermal and Evaporative Resistance of clothing Materials Using a Sweating Hot Plate; Part C. The specifics and allowable refinements are as follows:

- For a given replicate the temperatures, humidity, voltage and current are logged at 2 minute intervals with an acceptable steady-state deviation of no more than 1.5% for at least 30 minutes.
- Wind speed is set to 1 m/s with a turbulence value of ~0.07.
- Using system constants,  $R_{ef}$ ,  $R_{ef}^A$ , and  $Q_t$  are calculated for each replicate. The replicate values are averaged to provide overall sample averages as reported in this document.

### Calculation of Total Heat Loss Parameters

Calculation of the Total Heat Loss,  $Q_t$  [ $W/m^2$ ], requires measurements from both dry and sweating conditions on a hotplate. Each total heat loss calculation was derived from the average of three test replications. Total heat loss,  $Q_t$ , was calculated using the following formula:

$$Q_t = \frac{10^\circ C}{R_{cf} + .04} + \frac{3.57 \text{ kPa}}{R_{et}^A + .0035}$$

where:

$Q_t$  = Total Heat Loss (THL),

$R_{cf}$  = the average intrinsic thermal resistance of the sample alone and is determined by subtracting the average dry bare plate resistance ( $R_{cbp}$ ) from the average of the total thermal resistance ( $R_{ct}$ ) of the specimens tested,

$R_{ef}^A$  = Average apparent intrinsic evaporative resistance of the sample alone as determined by the apparent total evaporative resistance ( $R_{et}^A$ ) minus the average bare plate evaporative resistance ( $R_{ebp}$ ),

$R_{ct}$  = total thermal resistance of the specimen and surface air layer defined as

$$R_{ct} = \frac{(T_s - T_a) \cdot A}{H}$$

where:

$T_s$  = Temperature of the plate surface (35°C),

$T_a$  = Temperature in the local environment (25°C),

$A$  = area of the test plate (0.01 m<sup>2</sup>), and

$W$  = power input (W),

$R_{et}^A$  = apparent total evaporative resistance of the specimen and surface air layer defined as

$$R_{et}^A = \frac{(P_s - P_a) \cdot A / H - (T_s - T_a) \cdot A}{R_{ct}}$$

where:

$P_s$  = water vapor pressure at the surface plate (kPa),

$P_a$  = water vapor pressure in the local environment (kPa),

$A$  = area of the test plate (0.01 m<sup>2</sup>),

$H$  = power input (W),

$T_s$  = temperature at the plate surface (35°C),

$T_a$  = temperature at the local environment (25°C), and

$R_{ct}$  = total thermal resistance of the specimen and surface air layer  $[(\Delta^\circ\text{C})(\text{m}^2)/\text{W}]$ .

### Calculation of $I_t$ (clo) and $i_m$

$I_t$  (clo) values are derived using dry plate test results, from the following formula:

$$I_t = R_{ct} * 6.45$$

The  $i_m$  value (permeability index) is calculated, using both dry and sweating plate test results, from the following formula:

$$i_m = 0.060 * (R_{ct}/R_{et}^A)$$



## Appendix B: NCSU Sweating Thermal Hot Plate Results

### Sample - A

Rep	R <sub>ct</sub>	R <sub>et</sub> <sup>A</sup>	R <sub>cf</sub>	R <sub>ef</sub> <sup>A</sup>	I <sub>t</sub>	I <sub>m</sub>	Q <sub>t</sub>
1	0.082	0.00723	0.012	0.00156	0.529	0.681	898.31
2	0.082	0.00705	0.012	0.00138	0.529	0.698	923.62
3	0.082	0.00710	0.012	0.00143	0.529	0.693	916.79
<b>AVG</b>	<b>0.082</b>	<b>0.00713</b>	<b>0.012</b>	<b>0.00146</b>	<b>0.529</b>	<b>0.690</b>	<b>912.90</b>

### Sample - A

#### Weight

Rep	Weight (oz/yd <sup>2</sup> )
1	3.46
2	3.45
3	3.45
<b>Average</b>	<b>3.45</b>

**Sample - B**

Rep	R <sub>ct</sub>	R <sub>et</sub> <sup>A</sup>	R <sub>cf</sub>	R <sub>ef</sub> <sup>A</sup>	I <sub>t</sub>	I <sub>m</sub>	Q <sub>t</sub>
1	0.084	0.00732	0.014	0.00165	0.542	0.688	878.30
2	0.084	0.00715	0.014	0.00148	0.542	0.705	901.67
3	0.084	0.00720	0.014	0.00153	0.542	0.700	894.69
<b>AVG</b>	<b>0.084</b>	<b>0.00723</b>	<b>0.014</b>	<b>0.00156</b>	<b>0.542</b>	<b>0.698</b>	<b>891.55</b>

**Sample - B**

**Weight**

Rep	Weight (oz/yd <sup>2</sup> )
1	3.51
2	3.49
3	3.54
<b>Average</b>	<b>3.51</b>

**Sample - C**

Rep	R <sub>ct</sub>	R <sub>et</sub> <sup>A</sup>	R <sub>cf</sub>	R <sub>ef</sub> <sup>A</sup>	I <sub>t</sub>	I <sub>m</sub>	Q <sub>t</sub>
1	0.084	0.00688	0.014	0.00120	0.542	0.733	944.01
2	0.084	0.00705	0.014	0.00138	0.542	0.715	917.09
3	0.084	0.00697	0.014	0.00130	0.542	0.723	928.99
<b>AVG</b>	<b>0.084</b>	<b>0.00697</b>	<b>0.014</b>	<b>0.00129</b>	<b>0.542</b>	<b>0.724</b>	<b>930.03</b>

**Sample - C**

**Weight**

Rep	Weight (oz/yd <sup>2</sup> )
1	3.20
2	3.21
3	3.17
<b>Average</b>	<b>3.19</b>

**Sample - G**

Rep	R <sub>ct</sub>	R <sub>et</sub> <sup>A</sup>	R <sub>cf</sub>	R <sub>ef</sub> <sup>A</sup>	I <sub>t</sub>	I <sub>m</sub>	Q <sub>t</sub>
1	0.076	0.00807	0.006	0.00240	0.490	0.565	822.82
2	0.076	0.00774	0.006	0.00207	0.490	0.589	858.25
3	0.078	0.00800	0.008	0.00233	0.503	0.585	820.82
<b>AVG</b>	<b>0.077</b>	<b>0.00794</b>	<b>0.007</b>	<b>0.00227</b>	<b>0.495</b>	<b>0.580</b>	<b>833.96</b>

**Sample - G**

**Weight**

Rep	Weight (oz/yd <sup>2</sup> )
1	3.55
2	3.57
3	3.57
<b>Average</b>	<b>3.56</b>

**Sample - H**

Rep	R <sub>ct</sub>	R <sub>et</sub> <sup>A</sup>	R <sub>cf</sub>	R <sub>ef</sub> <sup>A</sup>	I <sub>t</sub>	I <sub>m</sub>	Q <sub>t</sub>
1	0.078	0.00817	0.009	0.00250	0.503	0.573	799.31
2	0.077	0.00803	0.008	0.00236	0.497	0.576	818.00
3	0.077	0.00774	0.008	0.00207	0.497	0.597	849.19
<b>AVG</b>	<b>0.077</b>	<b>0.00798</b>	<b>0.008</b>	<b>0.00231</b>	<b>0.499</b>	<b>0.582</b>	<b>822.17</b>

**Sample - H**

**Weight**

Rep	Weight (oz/yd <sup>2</sup> )
1	3.39
2	3.44
3	3.38
<b>Average</b>	<b>3.40</b>



## Appendix C: Metabolic Rate for Different Activities [1]\*

Activity		Metabolic Rate, M w/m <sup>2</sup>
<b>RESTING</b>		
Sleeping		40
Seated, quiet		60
Standing, relaxed		70
<b>WALKING</b>		
On the level	km/hr	
	3.2	115
	5.6	180
	8.0	330
Up a grade		
%Grade	km/hr	
5	3.2	170
5	6.4	350
15	3.2	260
15	4.8	400
25	3.2	385
<b>OFFICE WORK</b>		
Typing	Electrical	55
	Mechanical	65
Filing, Checking		60-65
<b>HEAVY WORK</b>		
Handling 50 kg bags		230
Digging trenches		345
Stag removal		435
<b>MISCELLANEOUS OCCUPATIONS</b>		
Laboratory Work		
	Examining slides	80
	General lab.work	90
	Setting up apparatus	125
Teacher		90
Vehicle driving		
	Car	60-115
	Heavy truck	180
<b>LEISURE ACTIVITIES</b>		
Gymnastics		170-230
Tennis		260
Wrestling		500

\*[1]: Fanger, P.O., "Thermal Comfort", McGraw Hill, New York, 24-26, (1970)



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**At KMI Zeolite Inc., we are proud to provide our clients with natural clinoptilolite zeolite from one of the largest and purest deposits in the world.**

Zeolite is a crystalline hydrated alumino-silicate that possesses a unique three-dimensional honeycomb framework. This structure creates a series of interconnecting channels and pores that account for over 50% of its total surface. As a result, zeolite acts as a molecular sieve that traps and binds particles of various sizes while allowing others to pass through. These characteristics provide it with exceptional absorption, adsorption and cation exchange capabilities.

As zeolite is a natural and non-toxic mineral, it provides a safe and effective means to absorb moisture, filter toxins, increase nutrient intake and remove odors. Above and beyond these features, we are set apart in the industry because our natural clinoptilolite zeolite is 97% pure. At KMI Zeolite Inc., we are proud to provide our clients with a product that is effective, environmentally friendly and of the highest possible quality.

## **Zeolite Applications**

Based on the characteristics of natural clinoptilolite zeolite, we have identified seven major applications for our product. They include the following:

1. Animal husbandry
2. Absorbents and reclamation
3. Water filtration
4. Soil treatment
5. Odor control
6. Traction control
7. Construction

### **1. Animal Husbandry**

One of the significant benefits of clinoptilolite zeolite is its ability to improve digestion and bind toxins in the digestive tract of animals. For instance, studies have demonstrated that zeolite absorbs 85% of ammonia (NH<sub>3</sub>) absorbed under a neutral pH, which can improve feed conversion by up to 5%.



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Studies have also found that zeolite has the ability to bind ammonia and hard metal cations in aqueous solutions. The results demonstrated that the use of zeolite at fish and shrimp farms vastly improved water quality and clarity.

Zeolite's ability to bind ammonia provides significant benefits to both agriculture and aquaculture industries. These include increased nutrient absorption and odor management. When KMI zeolite is used as an animal feed additive, mixed with manure or added to aqueous environments, clients are provided with a low-cost, effective and environmentally friendly product that provides safe, clean and efficient work environments for animals and workers.

### **The Major Benefits of Zeolite to Animal Husbandry**

- Promotes barn and stable environments that are clean and safe
- Increases growth rates
- Improves feed conversion rates
- Absorbs toxic elements in animal digestive tracts
- Improves the digestion of raw fibers
- Prevents soft feces, diarrhea, virus infections and disease
- Reduces the stress placed on animals and their digestive systems
- Increased survival rates in weanlings
- Facilitates the uptake and retention of essential nutrients including calcium (Ca), potassium (K), sodium (Na) and zinc (Zn)
- Controls fly populations by absorbing excess moisture in manure
- Absorbs manure odor
- Prevents caking in feeds
- Classified as GRAS (Generally Regarded as Safe) for animals and humans
- Non-toxic and safe for the environment
- Does not contain chemical additives or dyes

### **Animal Specific Benefits**

<b>Animal Type</b>	<b>Benefits</b>
Poultry	<ul style="list-style-type: none"><li>- Increases egg laying capacity</li><li>- Increases the hardness of eggshells</li><li>- Higher number of gradable eggs</li><li>- Increases weight gain, maturity and onset of laying</li><li>- Filtration of egg-wash water through zeolite granules removes solids and</li></ul>



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	bacteria such as E. Coli
Swine	<ul style="list-style-type: none"> <li>- Improves feed digestion</li> <li>- Increases growth and decreases finishing time</li> <li>- Reduces occurrence of scours</li> <li>- Promotes increased growth rates</li> <li>- Reduces methane emissions</li> </ul>
Cattle	<ul style="list-style-type: none"> <li>- Increases milk production in dairy cows</li> <li>- Promotes growth in calves by reducing diarrhea and stimulating appetite</li> <li>- Increases weight gain</li> <li>- Reduces instances of liver abscesses</li> <li>- Increases rumen buffering by stabilizing pH levels</li> </ul>
Horses	<ul style="list-style-type: none"> <li>- Absorbs moisture and creates a dry environment in stalls</li> <li>- Reduces hoof problems</li> </ul>
Tilapia/Shrimp	<ul style="list-style-type: none"> <li>- Improves water quality and clarity</li> <li>- Increases access to nutrients by removing toxins</li> <li>- Absorbs toxic gases including hydrogen sulfide (H<sub>2</sub>S) and methane (CH<sub>4</sub>)</li> <li>- Increases dissolved oxygen (DO) content of pond water</li> <li>- Stabilizes water pH levels by neutralizing organic waste</li> <li>- Removes ammonia and heavy metal cations</li> <li>- Promotes fish and shrimp growth</li> <li>- Restricts the growth of bacteria and blue-green weeds</li> <li>- Increases the sedimentation of suspended solids</li> <li>- Saturated zeolite can be reused as a soil amendment</li> </ul>

## 2. Absorbents and Reclamation

Over the past several years, environmental concerns have resulted in stringent regulations regarding the management of process materials and wastes. Mining, refining and metal processing industries are under increasing pressure to develop safe and low-cost ways to treat and store contaminants.

Recent studies involving the use of clinoptilolite zeolite in waste management and remediation practices have found that it is highly effective at removing hydrocarbons, radioactive cations, ammonia and heavy metal cations in industrial environments. Essentially, zeolite functions as a molecular sieve that adsorbs, absorbs, binds and immobilizes solid particles, liquids and gases in



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its honeycomb structure. As a result, zeolite prevents the release of contaminant and toxins into delicate ecosystems.

Zeolite has high adsorption capabilities, meaning that liquids, gases and suspended matter adhere to the surface of its internal pores. At the same time, zeolite has high absorbent capabilities, meaning that it can soak up and assimilate molecules into its structure. These complimentary abilities work in unison to bind and contain toxins and contaminants. For instance, zeolite is used at sewage treatment plants to absorb contaminated liquid and adsorb the ammonia (NH<sub>3</sub>) produced by microbial activity on the liquid surface.

Research conducted at KMI Zeolite Inc. determined that clinoptilolite zeolite is highly effective in industrial applications including gas production, the absorption of chemical spills and the purification of liquids and soil. Because our zeolite deposits have the highest purity rating on the market, we guarantee that our clients receive a maximum performance product that is low cost and meets environmental regulations in any industrial setting.

## **The Major Benefits of Zeolite as an Absorbent**

### *Physical structure*

Natural zeolite binds heavy metal cations within its honeycomb structure, meaning that they are no longer water soluble. As a result, toxins are locked into the mineral's framework without the threat of leaching back into the environment. Zeolite is also proven to absorb up to 60% of its weight in liquid and 30% of its weight in oil. Unlike clay absorbents, liquid saturation does not cause zeolite to swell or lose structural integrity. This prevents the creation of mud or a loss of traction on industrial sites.

### *Waste encapsulation*

Encapsulation refers to the process of mixing contaminants with water, zeolite and cement in order to create stable concrete blocks of disposable industrial waste. Natural zeolite acts as a molecular sieve that absorbs, stabilizes and immobilizes contaminants prior to encapsulation in the cement matrix. Its binding capabilities ensure that toxins lose their ability to leach or reduce the strength of concrete over time.





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The use of zeolite in encapsulation processes has passed the Toxicity Characteristic Leaching Procedure (TCLP) Test Method 1311, which is a standard designed to measure the mobility of organic and inorganic analytes in liquid and solid wastes.

### Application Specific Benefits

Application	Benefits
Industrial absorbent	<ul style="list-style-type: none"> <li>- Adsorbs, absorbs, filters and immobilizes industrial toxins in liquids and gases</li> <li>- Deodorizes by adsorbing and absorbing source gases</li> <li>- Filters toxins such as sulfur dioxide (SO<sub>2</sub>) from the air</li> <li>- Removes hydrogen sulfide (H<sub>2</sub>S) from sour gas</li> <li>- Neutralizes hazardous materials including inverted drilling waste and petroleum products with high saline content</li> <li>- Prevents the leaching of toxins into groundwater at landfill sites</li> <li>- Reduces and filters harmful odors caused by decomposition</li> </ul>
Radioactive waste encapsulation	<ul style="list-style-type: none"> <li>- Absorbs and immobilizes of radioactive cations like cesium (Cs) and strontium (Sr)</li> <li>- Proven radiation and thermal resistance</li> <li>- Binds radioactive cations in nuclear wastewater and polluted soils</li> <li>- Highly compatible with cement encapsulation methods</li> <li>- Prevents leaching of contaminants back into the environment</li> <li>- Prevents the corrosion of cement matrices created during encapsulation</li> </ul>
Hydrocarbon encapsulation	<ul style="list-style-type: none"> <li>- Demonstrated affinity for hydrocarbons</li> <li>- Absorbs hydrocarbons on contact</li> <li>- High propensity for benzene (C<sub>6</sub>H<sub>6</sub>) and other aromatics</li> <li>- Highly effective in the encapsulation process for drill cuttings and inverted drill fluids</li> <li>- Prolonged contact with hydrocarbon contaminants results in a higher volume of contaminant absorption</li> </ul>
Heavy metal absorption	<ul style="list-style-type: none"> <li>- Highly effective at removing contaminants from industrial and/or mine drainage</li> <li>- Binds and absorbs heavy metal cations in contaminated soil and aqueous environments</li> <li>- Strong adsorption and absorption capabilities prevent toxins from leaching into the environment</li> <li>- Creates strong bonds with cations including lead (Pb), zinc (Zn), copper (Cu), mercury (Hg) chromium (Cr), iron (Fe), manganese (Mn), aluminum (Al), silver (Ag) and cobalt (Co)</li> </ul>
Tailings remediation	<ul style="list-style-type: none"> <li>- Removes heavy metals from waste streams and acid mine drainage</li> </ul>



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	<ul style="list-style-type: none"> <li>- Prevents the contamination of agricultural products or groundwater</li> <li>- Highly effective at amending contaminated garden soils</li> <li>- Promotes soil remediation by binding heavy metal cations</li> <li>- Combats environmental problems linked to heavy metal pollution from wastewater irrigation, sewage sludge and mining practices</li> </ul>
Ammonia Removal	<ul style="list-style-type: none"> <li>- Highly effective at binding ammonia (NH<sub>3</sub>) and hydrogen sulfide (H<sub>2</sub>S) produced at rendering plants, sewage treatment plants, water waste treatment plants and agricultural settings</li> <li>- Prevents ammonia leakage into groundwater and aquifers</li> <li>- Removes odor created during sewage treatment processes</li> <li>- Highly effective in manure management and compost practices</li> <li>- Deodorizes environments such as feedlots, barns and stables</li> </ul>
Chemical Spills	<ul style="list-style-type: none"> <li>- Absorbs and deodorizes liquids like gasoline, oil, grease and petroleum products</li> <li>- Holds up to 30% of its weight in oil</li> <li>- Separates ammonia (NH<sub>3</sub>), hydrogen sulfide (H<sub>2</sub>S), carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and oxygen (O<sub>2</sub>) from gas streams</li> <li>- Absorbs floor spills in garages or laboratories</li> <li>- Proven ability to aid in clean-up processes of oil and gasoline spills</li> <li>- Causes oil to coagulate so it can be skimmed off liquid surfaces</li> </ul>
Mold Absorption	<ul style="list-style-type: none"> <li>- Deodorizes odors caused by mold growth in homes, offices and industrial settings</li> <li>- Absorbs moisture and dampness in basements and attics</li> <li>- Creates dry environments which prevent the growth of mildew</li> <li>- Filters airborne toxins and spores</li> <li>- Prevents the growth of mold inside building structures</li> <li>- Prevents microcapsule membrane damage in the mixing, casting and placing stages of anti-fungal mortar and concrete</li> <li>- Prevents the appearance of unsightly mold or rust stains on concrete surfaces</li> </ul>

### 3. Water Filtration

Water treatment refers to the removal of impurities (microorganisms, suspended solids or dissolved substances) from drinking water, industrial wastewater, hot tubs and the like. Granular materials such as sand have often been used to filter out impurities. However, research indicates that highly pure zeolite is superior to conventional granular media in terms of natural filtration and absorbent abilities in aqueous environments.



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At KMI Zeolite Inc., we are proud to provide natural clinoptilolite zeolite with a higher purity and quality rating than any of our competitors. Our product is over 97% pure, and we guarantee its superiority as a contaminant filter and absorbent in aqueous environments.

### **Zeolite vs. Conventional Filtration Media**

Lab data indicates that zeolite outperforms conventional filtration media, including sand and anthracite, in its filtration and absorption capabilities. This is attributed to zeolite's surface area, which is seven or eight times larger than many other granular materials. For instance, an ounce of pool sand has a surface area of 1,000 feet per cubic foot, whereas the same amount of zeolite has a surface area of 9,700,000 feet per cubic foot.

### **The Major Benefits of Zeolite in Water Filtration Processes**

Ammonia (NH<sub>3</sub>) and heavy metal cations are often found in water sources and pose serious health and environmental risks. Studies have determined that natural clinoptilolite zeolite is selective for these cations, meaning that it will absorb and bind them in its honeycomb structure even in the presence of larger amounts of competing cations. In addition, zeolite forms strong bonds with ammonia and heavy metals that are difficult to break. This prevents leaching of contaminants into the environment.

Other benefits include the following:

- High internal and external surface area which results in a high ion holding capacity
- Selective for heavy metal cations including zinc (Zn), copper (Cu), silver (Ag), lead (Pb), cobalt (Co) and nickel (Ni)
- Outperforms conventional granular media
- Highly effective at filtering and purifying water
- Cost effective
- Removes organic matter
- Abrasion resistant
- Dehydrates sludge
- Requires 50% less backwash cycles than sand
- Reduces the amount of backwash water due to a decreased number of backwash cycles
- Classified as GRAS (Generally Regarded As Safe) for humans and animals
- Non-toxic and environmentally friendly
- Does not contain chemical additives or dyes



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### Application Specific Benefits

Application	Benefits
Aquariums	<ul style="list-style-type: none"> <li>- Stabilizes ammonia levels while a biological filter is established</li> <li>- Provides a large surface area for the growth of nitrifying bacteria</li> <li>- Safe for aquatic life, plants and nitrifying bacteria</li> <li>- Absorbs dissolved organic compounds and heavy metals</li> <li>- Prevents new tank syndrome</li> <li>- Filters micro particles</li> <li>- Stabilizes water pH levels</li> <li>- Prevents algae growth</li> <li>- Improves water clarity</li> <li>- Zeolite filters can be cleansed in a saltwater solution and reused</li> </ul> <p><b>Zeolite is not for use in saltwater aquariums.</b></p>
Stormwater Management	<ul style="list-style-type: none"> <li>- Absorbs heavy metal pollutants that do not degrade in the natural environment</li> <li>- Filters dissolved and suspended metals like lead (Pb), copper (Cu) and zinc (Zn)</li> <li>- Absorbs arsenate, solvents and fuel components</li> <li>- High levels of contaminant absorption take place within the first hour of contact</li> </ul>
Drinking Water	<ul style="list-style-type: none"> <li>- Softens water by absorbing calcium (Ca) and magnesium (Mg)</li> <li>- Removes chlorine (Cl) from tap water</li> <li>- Removes iron (Fe) from ground water sources</li> <li>- Removes contaminants like heavy metals and ammonia (NH<sub>3</sub>)</li> <li>- Neutralizes slightly acidic water</li> <li>- Improves water clarity</li> <li>- Provides better liquid/solid separation than other filters such as alum and polymer</li> <li>- Capable of replacing sand and anthracite in gravity and pressure vessel filters</li> </ul>
Pools and Hot Tubs	<ul style="list-style-type: none"> <li>- Absorbs nitrates (NO<sub>3</sub>), ammonia (NH<sub>3</sub>), phosphates (PO<sub>4</sub>), iron (Fe), manganese (Mn)</li> <li>- Traps and captures skin and blood cells</li> <li>- Removes bacteria algae and cryptosporidium</li> <li>- Prevents the leaching of contaminants</li> <li>- Prevents the formation of chloramines which cause eye irritation</li> <li>- Prevents odors</li> <li>- Improves water clarity</li> <li>- Zeolite filters can be kept clean with fewer backwash cycles than sand filters</li> </ul>



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Ponds	<ul style="list-style-type: none"> <li>- Filters and absorbs ammonia (NH<sub>3</sub>), nitrates (NO<sub>3</sub>) and phosphates (PO<sub>4</sub><sup>3-</sup>)</li> <li>- Absorbs ammonia at a faster rate than nitrifying bacteria</li> <li>- Prevents the growth of algae</li> <li>- Improves water pH balance</li> <li>- Filters fine particles and dissolved compounds</li> <li>- Improves water clarity</li> <li>- Classified as GRAS (Generally Regarded As Safe) for aquatic animals and plants</li> <li>- Zeolite filter can be cleansed in a saltwater solution and reused</li> </ul> <p><b>Zeolite is not for use in saltwater ponds.</b></p>
Mining tailing ponds	<ul style="list-style-type: none"> <li>- Adsorbs and binds heavy metals and cyanide (CN<sup>-</sup>) found in mine waters</li> <li>- Dehydrates and deodorizes sludge</li> <li>- Capable of reducing liquid effluent to solid waste that can be safely controlled</li> <li>- Prevents leaching due to the strong bonds formed between zeolite and heavy metals</li> <li>- Prevents heavy metals and cyanide (CN<sup>-</sup>) from entering streams and aquifer systems</li> <li>- Absorbs heavy metal cations including silver (Ag), cobalt (Co), manganese (Mn), aluminum (Al), cesium (Cs), magnesium (Mg), arsenic (As), copper (Cu), molybdenum (Mo), cadmium (Cd), iron (Fe), nickel (Ni), chromium (Cr), mercury (Hg), lead (Pb), strontium (Sr), uranium (U), zinc (Zn)</li> </ul>

#### 4. Soil Treatment

In order to achieve sustainable grass, plant and crop growth, soil must have the following characteristics:

- Moisture retention;
- Appropriate nutrient concentrations;
- Non-toxic levels of contaminants;
- Sufficient aeration.





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The characteristics of natural clinoptilolite zeolite match perfectly with the requirements listed above. Its large surface area, molecular structure and porosity provide it with the ability to retain moisture and nutrients, remove toxins through cation exchanges and promote aeration. These features make natural zeolite the perfect product to maximize growth rates and promote plant health in gardens, turf-grass seeding, golf greens and sod.

KMI Zeolite Inc. provides natural zeolite that is higher in quality and purity than any product offered by our competitors. Our zeolite is proven to be over 97% pure, meaning that its sodium and clay concentrations are less than 3%. We are proud to offer clients top quality zeolite products that are low in cost, environmentally friendly and maximize the value of soils and compost materials.

### **The Major Benefits of Zeolite in Soil Treatment Products**

- Storehouse for essential plant nutrients including nitrate (NO<sub>3</sub>-), phosphate (PO<sub>4</sub><sup>3-</sup>) and potassium (K)
- High surface area provides soil with aeration and water retention capabilities
- Retains 50% of its weight in water and nutrients
- Buffers soil pH levels
- Increases germination rates
- Increases the growth rate of grains, grasses and plants
- Granules do not decompose or degrade in the environment
- High nutrient retention reduces the number of fertilizer treatments required each season
- Blends in with golf greens and lawns because of its natural green color
- Classified as GRAS (Generally Regarded As Safe) for humans and animals
- Non-toxic and environmentally friendly
- 100% natural and organic
- Does not contain added chemicals or dyes

### **Application Specific Benefits**

Application	Benefits
Soil Amendment and Additive	<ul style="list-style-type: none"><li>- Moderates the nitrification of ammonia (NH<sub>3</sub>)</li><li>- Increases the germination speed of grasses and grains</li><li>- Reduces run-off of ammonia (NH<sub>3</sub>) and nitrate (NO<sub>3</sub>) into</li></ul>



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	<p>ground water</p> <ul style="list-style-type: none"> <li>- Enhances soil texture</li> <li>- Controls nutrient assets by inhibiting release rates</li> <li>- Prevents leaching or vaporization of essential plant nutrients</li> <li>- High water retention capabilities reduce the amount of irrigation water required each season</li> <li>- High surface area and porosity prevents soil compaction</li> <li>- Improves the aeration of deep root systems</li> <li>- Prevents the accumulation of sodium (Na) in soil</li> <li>- Safe and non-toxic for humans or animals</li> <li>- 100% natural and highly suited for use in organic fertilizers</li> <li>- Ideal for use in public areas including sports fields and parks</li> <li>- Ideal for use with high value crops such as vegetables, fruits, potatoes and alfalfa</li> </ul>
Golf Courses	<ul style="list-style-type: none"> <li>- Increases grass shoot growth rates</li> <li>- Speeds the establishment rate of grasses</li> <li>- Promotes strong root development</li> <li>- High water retention promotes grass growth during times of limited water availability</li> <li>- Reduces nitrogen (N) leaching</li> <li>- Promotes nitrogen (N) recovery in golf course sands</li> <li>- Balances the pH levels of soils</li> <li>- Prevents root burning by moderating the release of ammonia in the soil</li> <li>- Natural green color blends with grass on greens, fairways and driving ranges</li> </ul>
Gardening	<ul style="list-style-type: none"> <li>- Increases seed germination rates</li> <li>- Increases the speed of sprout emergence</li> <li>- Promotes root growth and mass</li> <li>- Reduces the leaching and evaporation of essential plant nutrients like ammonia (NH<sub>3</sub>), nitrogen (N) and phosphorus (P)</li> <li>- Holds moisture and nutrients in the root zone</li> <li>- Promotes aeration by preventing soil compaction</li> <li>- High nutrient retention capabilities reduce the number of fertilizer treatments required each season</li> <li>- Reduces odors caused by various fertilizers and manure</li> <li>- Controlled release of ammonia (NH<sub>3</sub>) prevents root burn</li> <li>- 100% natural and highly suited to organic gardening</li> </ul>
Composting	<ul style="list-style-type: none"> <li>- Large surface area provides a platform for microbiological activity</li> <li>- Filters excess amounts of sodium (Na) and heavy metals</li> </ul>



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	<ul style="list-style-type: none"> <li>- Prevents leaching of nitrogen (N) and phosphate (PO<sub>4</sub><sup>3-</sup>) into ground water</li> <li>- Prevents ammonia (NH<sub>3</sub>) losses resulting from vaporization</li> <li>- Retains nitrogen (N) for nutrient release at plant root systems</li> <li>- Reduces odors caused by ammonia (NH<sub>3</sub>) and biodegradable materials</li> </ul>
Hydroponics	<ul style="list-style-type: none"> <li>- High buffering abilities against changes in pH levels</li> <li>- Increases plant and crop growth rates</li> <li>- Reduces blossom-end rot</li> <li>- Controlled release of water and essential nutrients like potassium (K) and ammonia (NH<sub>3</sub>)</li> <li>- Improves crop yields and fruit quality</li> <li>- Buffering agent against heavy metal cations dissolved in hydroponic solutions</li> <li>- Prevents the onset of salt stress</li> </ul>
Aquaculture	<ul style="list-style-type: none"> <li>- Removes excess amounts of ammonia (NH<sub>3</sub>) and phosphorus (P) from recirculating water</li> <li>- Restricts the growth of algal blooms</li> <li>- Increases dissolved oxygen (DO) content</li> <li>- Stabilizes pH levels of aqueous environments</li> <li>- Absorbs contaminants such as hydrogen sulfide (H<sub>2</sub>S)</li> <li>- Restricts the growth of harmful bacteria and blue-green weeds</li> <li>- Provides an environment for the cultivation of beneficial bacterial populations</li> <li>- Saturated zeolite chips used in fresh water farming can be reused as slow-release fertilizers</li> </ul>

## 5. Odor Control

Unlike air fresheners or perfumes, zeolite does not mask odors; it removes them. Because of its porosity and cation exchange capacity, noxious odors are trapped inside its crystalline structure and removed from the surrounding environment.

Many odors in barns, stalls or animal litter areas are generated from a conversion of ammonium (NH<sub>4</sub><sup>+</sup>) to ammonia gas (NH<sub>3</sub>). Zeolite works by absorbing moisture from animal waste and trapping ammonium before it has an opportunity to vaporize. Then, ammonium is held in its honeycomb structure where it is not water soluble.



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In addition, saturated zeolite used in stables or kitty litter can be disposed of in gardens, plant beds or compost piles. Here, zeolite slowly releases the trapped ammonium to plant root systems, and acts as a natural fertilizer and aeration agent.

At KMI Zeolite Inc., we are proud to offer our clients with effective odor control products that are of the highest quality, environmentally friendly and safe for families and pets. We guarantee that our products do not contain chemical additives, dyes or perfumes.

### Application Specific Benefits

Application	Benefits
Barn Deodorizers	<ul style="list-style-type: none"> <li>- Adsorbs ammonium (NH<sub>4</sub><sup>+</sup>)</li> <li>- Absorbs urine and other liquids</li> <li>- Promotes clean barn environments</li> <li>- Controls fly populations</li> <li>- Removes excess bacterial products from the air</li> <li>- Improved working environment for staff</li> <li>- Reduces stress on animals</li> <li>- Non-toxic and environmentally friendly</li> <li>- 100% natural and organic</li> <li>- Classified as GRAS (Generally Regarded As Safe) for animals and humans</li> </ul>
Stall Freshener	<ul style="list-style-type: none"> <li>- Adsorbs ammonium (NH<sub>4</sub><sup>+</sup>)</li> <li>- Absorbs urine and other liquids</li> <li>- Compatible with all bedding materials</li> <li>- Extends bedding life</li> <li>- Controls fly populations</li> <li>- Removes excess bacterial products from the air</li> <li>- Prevents against respiratory problems in horses</li> <li>- Reduces hoof problems</li> <li>- Provides added traction to stall floors</li> <li>- Does not contain chemicals, dyes or artificial fragrances</li> <li>- Non-toxic and environmentally friendly</li> <li>- 100% natural and organic</li> <li>- Classified as GRAS (Generally Regarded As Safe) for animals and humans</li> <li>- Saturated zeolite can be used as a soil amendment</li> </ul>
Kitty Litter	<ul style="list-style-type: none"> <li>- Traps and holds pet odors</li> <li>- Adsorbs ammonium (NH<sub>4</sub><sup>+</sup>)</li> <li>- Absorbs liquids and salts from cat waste</li> </ul>



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	<ul style="list-style-type: none"> <li>- Reduces tracking</li> <li>- Minimizes excess dust</li> <li>- Effective clumping for easy clean up</li> <li>- Does not contain sodium bentonite</li> <li>- Does not contain chemicals, dyes or artificial fragrances</li> <li>- Non-carcinogenic</li> <li>- 100% natural and organic</li> <li>- Classified as GRAS (Generally Regarded As Safe) for animals and humans</li> <li>- Litter can be disposed of in plant beds, gardens or compost piles</li> </ul>
Household odors	<ul style="list-style-type: none"> <li>- Absorbs pet, smoke, shoe, compost and food odors</li> <li>- Deodorizes refrigerators, freezers, cloths hampers and diaper pails</li> <li>- Safe for use on carpet, furniture and upholstery</li> <li>- Freshens basements and crawl areas</li> <li>- Highly effective absorbent for floor spills in the garage or shop, drain fields or basement backups</li> <li>- Does not irritate skin</li> <li>- Non-toxic and environmentally friendly</li> <li>- 100% natural and organic</li> <li>- Does not contain chemicals, dyes or artificial fragrances</li> <li>- Classified as GRAS (Generally Regarded As Safe) for animals and humans</li> </ul>

## 6. Traction Control

KMI Zeolite Inc. is proud to provide clients with clinoptilolite zeolite products that are 100% natural and organic, making them the most environmentally friendly materials available on the market for traction control.

Zeolite's unique honeycomb structure provides it a large internal and external surface area as well as structural integrity. These characteristics allow it to absorb 55% of its weight in water without swelling or creating mud. The physical durability and water absorption abilities of natural zeolite make it the ideal product for long term traction control.

Natural zeolite creates traction control on roads or sidewalks in two ways. First, it absorbs the microscopic layer of water that sits on top of ice. Secondly, it becomes embedded into ice and snow creating a long lasting sandpaper-like surface.





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Unlike rock salt or chemical ice melters, natural clinoptilolite zeolite is environmentally friendly and non-toxic. It can be used in public and domestic areas without health or safety risks to children or pets.

### **Natural Zeolite vs. Rock Salt Products**

Salt products are often used by municipalities and homeowners to provide traction control on ice and snow. While they are effective, there are many financial and environmental disadvantages associated with these products. For instance, salt is corrosive and causes billions of dollars in damage each year to vehicles, roads and bridges. In addition, salt leach harmful residue into groundwater systems and drinking water during spring melts. This creates additional pollution filtration expenses for municipalities.

In addition, salt is costly and loses its effectiveness when temperatures drop several degrees below freezing. As a result, it is necessary to switch to other products during the coldest months of winter in order to provide sufficient traction control on roads and sidewalks.

At KMI Zeolite Inc., we provide an economically viable and pollution free alternative to rock salt. Because our zeolite is 97% pure, it is guaranteed not to damage or rust vehicles and infrastructure. In addition, it runs no risk of contaminating water sources. In fact, it is often used in water filtration systems. Finally, zeolite does not have the temperature limitations of salt products, and will remain effective to temperatures of -13 Fahrenheit/-25 Celsius.

### **The Major Benefits of Zeolite as a Traction Control Agent**

- Maintains its structural integrity even when saturated with liquid
- Does not corrode concrete, metal, brick or stone
- Does not dissolve in water
- Instantly grips to ice and snow during freezing rain storms
- Dark green color absorbs solar rays and accelerates the melting of snow and ice
- Absorbs the microscopic layer of water that sits above ice
- Reduces tracking because of embedding characteristics
- Free of chemicals and dyes
- Does not irritate skin
- 100% natural and organic



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- Non-toxic to children, pets and grass

### Application Specific Benefits

Application	Benefits
Industrial ice melts	<ul style="list-style-type: none"> <li>- Creates a long lasting sandpaper-like surface</li> <li>- Ideal for use in areas where snow and ice are packed down</li> <li>- Resistant to freezing and clumping</li> <li>- Natural green color indicates where product is placed and prevents over or under application</li> <li>- Embedding abilities provide better traction control than sand or salt</li> <li>- Absorbs solar radiation and accelerates the melting of ice and snow</li> <li>- Does not burn or damage lawns, plants or trees</li> <li>- Saturated product can be swept up and used as a natural fertilizer in plant beds or gardens</li> </ul>
Walking paths	<ul style="list-style-type: none"> <li>- Creates a sandpaper-like surface on walkways, sidewalks, ramps, stairs and driveways</li> <li>- Does not damage concrete, brick, stone or paint</li> <li>- Does not stain clothing or carpets</li> <li>- Natural green color indicates where product is placed and prevents over or under application</li> <li>- Highly visible color provides proof that traction control agents are in use on your property</li> <li>- Product turns to dust under heavy pedestrian traffic and reduces clean up in the spring</li> <li>- 100% natural and organic</li> <li>- Safe for children, pets and lawns</li> <li>- Saturated product can be swept up and used as a natural fertilizer in plant beds or gardens</li> </ul>
Roads	<ul style="list-style-type: none"> <li>- Provides superior traction due to its ability to embed into ice and snow</li> <li>- Provides instant traction control during ice storms and freezing rain</li> <li>- Does not dissolve as ice and snow melt</li> <li>- Does not rust vehicles or metal infrastructure</li> <li>- Does not cause damage to road surfaces or bridges</li> <li>- Non-toxic and non-polluting</li> <li>- Controls dust on gravel roads after snow has melted</li> </ul>

## 7. Construction

Natural clinoptilolite zeolite is an aluminum silicate that has a unique honeycomb structure. Its large surface area and high ion exchange capacity make it extremely effective at absorbing



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water, binding calcium hydroxide (CH) and reflecting electromagnetic radiation. Research conducted at KMI Zeolite Inc. has found that these abilities are necessary in the creation of lightweight concrete and electromagnetic interference (EMI) shields.

At KMI Zeolite Inc., we are proud to provide our clients with clinoptilolite zeolite from the largest and purest zeolite deposit in the United States. We guarantee a product of the highest quality in order to maximize results in the creation of lightweight concrete and EMI shields.

### **The Major Benefits of Zeolite in Concrete and EMI Shield Production**

Water is the primary solvent for cement and ensures that materials like coarse aggregate, fine aggregate and additives mix evenly together. However, when water evaporates from concrete pores, it leaves behind void content that can ultimately decrease the final strength of the product. One solution to this problem has been to add siliceous and aluminous materials called pozzolans to cement mixes in order to prolong hydration time. The end result is an increase in the initial and final strength of concrete.

Zeolite is a naturally occurring aluminum silicate and can be used as a highly effective pozzolan. Research shows that it consumes calcium hydroxide (CH) and creates a low-density C-S-H gel that fills void concrete pores left behind by evaporated water. This process increases the overall strength and uniformity of lightweight concrete.

Research has also discovered that zeolite's aluminum silicate composition provides it with electrical, chemical and thermal properties that reflect electromagnetic radiation. As a result, zeolite can be used in ink mixtures and paint compositions that form the protective undercoat of EMI shields. These barriers protect against disruptions to the operation of electronic devices when they come into contact with electromagnetic fields. Essentially, the use of zeolite in EMI shields protects against disturbances in equipment performance or the degradation and loss of important data.

### **Application Specific Benefits**

<b>Application</b>	<b>Benefits</b>
Lightweight concrete	<ul style="list-style-type: none"><li>- Lower in cost than other pozzolans including silica fume</li><li>- Increases the compressive strength of concrete</li><li>- Increases the durability of concrete</li><li>- Improves chemical resistance in salt water applications</li><li>- Resists underwater corrosion</li></ul>



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	- Lowers emission of greenhouse gases during cement production
EMI Shields	<ul style="list-style-type: none"> <li>- Highly cost effective</li> <li>- Improves insulation properties</li> <li>- Reflects electromagnetic radiation</li> <li>- Highly effective in conductive coatings, tiles and fabrics</li> <li>- Highly effective in conductive paints for antistatic coatings</li> <li>- Resistant to acids and alkalis</li> <li>- Not soluble in water or other solvents</li> <li>- Light weight, low density, and high particle strength</li> </ul>

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## Popular Google Terms: Search Optimization Strategies

<b>Animal Husbandry</b>	
<ul style="list-style-type: none"> <li>• Natural zeolite</li> <li>• Zeolite uses</li> <li>• Zeolite structure</li> <li>• Zeolite uses agriculture</li> <li>• Zeolite animal feed</li> <li>• Zeolite animal husbandry</li> <li>• Zeolite animal health</li> <li>• Zeolite uses benefits</li> <li>• Zeolite facts</li> <li>• Health benefits zeolite</li> </ul>	<ul style="list-style-type: none"> <li>• Zeolite diarrhea</li> <li>• Zeolite detox</li> <li>• Natural zeolite mineral</li> <li>• Natural zeolite clinoptilolite</li> <li>• Natural zeolite clinoptilolite suppliers</li> <li>• Natural zeolite suppliers</li> <li>• Zeolite products</li> <li>• Clinoptilolite detox</li> <li>• Clinoptilolite deodorizers</li> <li>• Clinoptilolite benefits</li> </ul>
<b>Absorbents and Reclamation</b>	
<ul style="list-style-type: none"> <li>- Zeolite industrial uses</li> <li>- Zeolite for industry</li> <li>- Zeolite industrial applications</li> <li>- Zeolite in industrial separation and catalysis</li> <li>- Zeolite oil absorbent</li> <li>- Zeolite odor absorbent</li> <li>- Zeolite adsorb nitrogen</li> <li>- Zeolite adsorbent (adsorption)</li> <li>- Zeolite absorbent (absorption)</li> </ul>	<ul style="list-style-type: none"> <li>- Heavy metal detox procedure</li> <li>- Ways to detox heavy metals</li> <li>- Zeolite powder how to use</li> <li>- Tailings and mine waste</li> <li>- Ammonia removal zeolite</li> <li>- Clinoptilolite zeolite ammonia removal</li> <li>- Zeolite filters ammonia removal</li> <li>- Chemical spill procedure</li> <li>- Chemical spill kit</li> <li>- Zeolite mold</li> </ul>



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<ul style="list-style-type: none"> <li>- Zeolite absorbs radiation</li> <li>- Zeolite odor absorber</li> <li>- Zeolite nitrogen absorber</li> <li>- Remove ammonia zeolite</li> <li>- Zeolite radioactive waste</li> <li>- Zeolite as hydrocarbon traps</li> <li>- Zeolite heavy metal detox</li> <li>- Zeolite heavy metal toxicity</li> </ul>	<ul style="list-style-type: none"> <li>- Zeolite antifungal</li> <li>- Toxicity zeolite</li> <li>- Mercury toxicity zeolite</li> <li>- Zeolite copper toxicity</li> <li>- Zeolite toxin binder</li> <li>- Zeolite heavy metal removal</li> <li>- Zeolite heavy metal poisoning</li> </ul>
<b>Water Filtration</b>	
<ul style="list-style-type: none"> <li>- Zeolite water filter</li> <li>- Zeolite water filtration</li> <li>- Zeolite water filter media</li> <li>- Zeolite water filter manufacturers</li> <li>- Zeolite filter media water treatment</li> <li>- Zeolite for water purification</li> <li>- Zeolite filtration</li> <li>- Granular zeolite media</li> <li>- Zeolite aquarium filter</li> <li>- Zeolite aquarium filtration</li> <li>- Zeolite aquarium filter media</li> <li>- Zeolite aquarium substrate</li> <li>- Zeolite pond media</li> <li>- Zeolite pond filter</li> <li>- Zeolite pond water</li> <li>- Zeolite pond filter media</li> </ul>	<ul style="list-style-type: none"> <li>- Stormwater management</li> <li>- Stormwater runoff</li> <li>- Stormwater management plan</li> <li>- Stormwater drainage</li> <li>- Zeolite drinking water</li> <li>- Zeolite drinking water filter</li> <li>- Drinking zeolite</li> <li>- Zeolite pool filter</li> <li>- Zeolite pool sand</li> <li>- Zeolite pool filter media</li> <li>- Pool filter comparison</li> <li>- Sand filter media replacement</li> <li>- Mining tailing ponds</li> <li>- Mining tailing pond water treatment</li> <li>- Tailing ponds mining industry</li> </ul>
<b>Soil Treatment</b>	
<ul style="list-style-type: none"> <li>- Zeolite soil amendment</li> <li>- Zeolite water retention</li> <li>- Zeolite for turf</li> <li>- Zeolite soil conditioner</li> <li>- Zeolite golf</li> <li>- Adding zeolite to soil</li> <li>- Zeolite golf course</li> <li>- Zeolite golf greens</li> <li>- Zeolite plant</li> <li>- Zeolite composting</li> <li>- Compost zeolite</li> <li>- Aquaculture zeolite</li> </ul>	<ul style="list-style-type: none"> <li>- Soil additives for gardening</li> <li>- Soil additives for moisture retention</li> <li>- Soil additives to retain moisture</li> <li>- Soil additives for roses</li> <li>- Soil additives for blueberries</li> <li>- Zeolite garden</li> <li>- Zeolite garden soil</li> <li>- Zeolite garden products</li> <li>- Using zeolite garden</li> <li>- Hydroponic zeolite</li> <li>- Zeolite hydroponics</li> <li>- Zeolite aquarium</li> </ul>



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<ul style="list-style-type: none"> <li>- Use zeolite aquaculture</li> <li>- Application zeolite aquaculture</li> <li>- Zeolite aquarium substrate</li> <li>- Freshwater aquarium zeolite</li> </ul>	<ul style="list-style-type: none"> <li>- Zeolite aquarium filter</li> <li>- Zeolite aquaponics</li> <li>- Zeolite aquaculture</li> <li>- Zeolite ammonia remover</li> </ul>
<b>Odor Control</b>	
<ul style="list-style-type: none"> <li>- Zeolite odor remover</li> <li>- Zeolite odor removal</li> <li>- Zeolite odor absorber</li> <li>- Zeolite odor control</li> <li>- Zeolite crystals odor removal</li> <li>- Zeolite household</li> <li>- Zeolite household uses</li> <li>- Zeolite odor eliminator</li> <li>- Volcanic zeolite odor eliminator</li> <li>- House odor removal</li> <li>- House odor eliminator</li> <li>- Home odor removal</li> <li>- Home odor eliminator</li> </ul>	<ul style="list-style-type: none"> <li>- Zeolite air freshener</li> <li>- Volcanic zeolite</li> <li>- Bad odor</li> <li>- Zeolite cat litter</li> <li>- Zeolite cat litter compost</li> <li>- Zeolite cat litter freshener</li> <li>- Cat litter zeolite</li> <li>- Cat litter made zeolite</li> <li>- Zeolite kitty litter</li> <li>- Zeolite kitty crystals</li> </ul>
<b>Traction Control</b>	
<ul style="list-style-type: none"> <li>- Zeolite traction</li> <li>- Zeolite traction control</li> <li>- Traction control in snow</li> <li>- Traction control ice</li> <li>- Traction control icy</li> <li>- Traction control ice snow</li> <li>- Roadway snow and ice control</li> <li>- Snow control</li> </ul>	<ul style="list-style-type: none"> <li>- Ice control</li> <li>- Ice control sidewalk</li> <li>- Industrial ice melt</li> <li>- Industrial ice melter</li> <li>- Industrial strength ice melt</li> <li>- Traction walking ice</li> <li>- Traction walking snow</li> </ul>
<b>Construction</b>	
<ul style="list-style-type: none"> <li>• Zeolite lightweight concrete</li> <li>• Lightweight zeolite concrete</li> <li>• Zeolite-based lightweight concrete</li> <li>• Zeolite and concrete</li> <li>• Lightweight concrete mix</li> <li>• Lightweight concrete</li> </ul>	<ul style="list-style-type: none"> <li>• Lightweight cement</li> <li>• Lightweight cement mix</li> <li>• EMI shielding</li> <li>• Electromagnetic interference shielding materials</li> <li>• Electromagnetic interference shielding</li> </ul>