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TO ALL WHOM IT MAY CONCERN:

Be it known that I, DIETER MANSTEIN, residing at 50 Bloom Street,
Boston, MA 02114, have invented an improvement in

**METHOD AND APPARATUS FOR DERMATOLOGICAL TREATMENT AND
FRACTIONAL WOUNDING**

of which the following is a

SPECIFICATION

BACKGROUND OF THE INVENTION

Field Of The Invention

[0001] The present invention relates to methods and apparatus that use heat and/or electromagnetic radiation for dermatological treatment and, more particularly to a method and apparatus that uses heat and/or electromagnetic radiation to ablate or damage selected portions of a target area for dermatological treatment.

Background Art

[0002] There is an increasing demand for repair of or improvement to skin defects, which can be induced by aging, sun exposure, dermatological diseases, traumatic effects, and the like. Many treatments which use electromagnetic radiation have been used to improve skin defects by inducing a thermal injury to the skin, which results in a complex wound healing response of the skin. This leads to a biological repair of the injured skin.

[0003] Various techniques providing this objective have been introduced in recent years. The different techniques can be generally categorized in two groups of treatment modalities: ablative laser skin resurfacing ("LSR") and non-ablative collagen remodeling ("NCR"). The first group of treatment modalities, i.e., LSR, includes causing thermal

damage to the epidermis and/or dermis, while the second group, i.e., NCR, is designed to spare thermal damage of the epidermis.

[0004] LSR with pulsed CO₂ or Er:YAG lasers, which may be referred to in the art as laser resurfacing or ablative resurfacing, is considered to be an effective treatment option for signs of photo aged skin, chronically aged skin, scars, superficial pigmented lesions, stretch marks, and superficial skin lesions. However, patients may experience major drawbacks after each LSR treatment, including edema, oozing, and burning discomfort during first fourteen (14) days after treatment. These major drawbacks can be unacceptable for many patients. A further problem with LSR procedures is that the procedures are relatively painful and therefore generally require an application of a significant amount of analgesia. While LSR of relatively small areas can be performed under local anesthesia provided by injection of an anestheticum, LSR of relatively large areas is frequently performed under general anesthesia or after nerve blockade by multiple injections of anesthetic.

[0005] Any LSR treatment results in thermal skin damage to the treatment area of the skin surface, including the epidermis and/or the dermis. LSR treatment with pulsed CO₂ lasers is particularly aggressive, causing thermal skin damage to the epidermis and at least to the superficial dermis. Following LSR treatment using CO₂ lasers, a high incidence of complications can occur, including persistent erythema, hyperpigmentation, hypopigmentation, scarring, and infection (e.g., infection with Herpes simplex virus). LSR treatment with the Er:YAG laser has been introduced as a more gentle alternative to the CO₂ laser, due to the lesser penetration depth of the Er:YAG pulsed laser. Using the Er:YAG laser results in a thinner zone of thermal injury within the residual tissue of the target area of the skin. However, LSR that uses the Er:YAG laser produces side effects similar to those made by LSR that uses the CO₂ laser within the first days after treatment.

[0006] A limitation of LSR using CO₂ or Er:YAG lasers is that ablative laser resurfacing generally can not be performed on the patients with dark complexions. The removal of pigmented epidermis tissue can cause severe cosmetic disfigurement to patients with a dark complexion, which may last from several weeks up to years, which is considered by

most patients and physicians to be unacceptable. Another limitation of LSR is that ablative resurfacing in areas other than the face generally have a greater risk of scarring. LSR procedures in areas other than the face result in an increased incidence of an unacceptable scar formation because the recovery from skin injury within these areas is not very effective.

[0007] In an attempt to overcome the problems associated with LSR procedures, a group of NCR techniques has emerged. These techniques are variously referred to in the art as non-ablative resurfacing, non-ablative subsurfacing, or non-ablative skin remodeling. NCR techniques generally utilize non-ablative lasers, flashlamps, or radio frequency current to damage dermal tissue while sparing damage to the epidermal tissue. The concept behind NCR techniques is that the thermal damage of only the dermal tissues is thought to induce wound healing which results in a biological repair and a formation of new dermal collagen. This type of wound healing can result in a decrease of photoaging related structural damage. Avoiding epidermal damage in NCR techniques decreases the severity and duration of treatment related side effects. In particular, post procedural oozing, crusting, pigmentary changes and incidence of infections due to prolonged loss of the epidermal barrier function can usually be avoided by using the NCR techniques.

[0008] Various strategies are presently applied using nonablative lasers to achieve damage to the dermis while sparing the epidermis. Nonablative lasers used in NCR procedures have a deeper dermal penetration depth as compared to ablative lasers used in LSR procedures. Wavelengths in the near infrared spectrum can be used. These wavelengths cause the non-ablative laser to have a deeper penetration depth than the very superficially-absorbed ablative Er:YAG and CO₂ lasers. The dermal damage is achieved by a combination of proper wavelength and superficial skin cooling, or by focusing a laser into the dermis with a high numerical aperture optic in combination with superficial skin cooling. While it has been demonstrated that these techniques can assist in avoiding epidermal damage, one of the major drawbacks of these techniques is their limited efficacies. The improvement of photoaged skin or scars after the treatment with NCR techniques is significantly smaller than the improvements found when LSR ablative techniques are utilized. Even after multiple treatments, the clinical improvement is often

far below the patient's expectations. In addition, clinical improvement is usually several months delayed after a series of treatment procedures.

[0009] Another limitation of NCR procedures relates to the breadth of acceptable treatment parameters for safe and effective treatment of dermatological disorders. The NCR procedures generally rely on an optimum coordination of laser energy and cooling parameters, which can result in an unwanted temperature profile within the skin leading to either no therapeutic effect or scar formation due to the overheating of a relatively large volume of the tissue.

[0010] Yet another problem of non-ablative procedures relates to the sparing of the epidermis. While sparing the epidermis is advantageous in order to decrease the side effects related to complete removal of the epidermis, several applications of NCR procedures may benefit from at least partial removal of epidermal structures. For example, photoinduced skin aging manifests not only by the dermal alterations, but also by epidermal alterations.

[0011] A further problem of both ablative and nonablative resurfacing is that the role of keratinocytes in the wound healing response is not capitalized upon. Keratinocyte plays an active role in the wound healing response by releasing cytokines when the keratinocyte is damaged. During traditional ablative resurfacing procedures, the keratinocytes are removed from the skin along with the epidermis, thereby removing them from the healing process altogether. On the other hand, in traditional non-ablative procedures, the keratinocytes, which are located in the epidermis, are not damaged, therefore they do not release cytokines to aid in the healing process.

[0012] Another major problem with all LSR and NCR techniques now used is the appearance of visible spots and/or edges after treatment due to inflammation, pigmentation, or texture changes, corresponding to the sites of treatment. Devices for LSR and NCR produce macroscopic (easily seen) sexposure areas. For example, laser exposure spot diameters typically vary from about 1 to 10 mm, and NCR exposure spot diameters from about 3 to 50 mm. Some devices, such as indense pulsed light devices, leave "boxes" of skin response due to rectangular output patterns on the skin. Patients do

not like such spot or box patterns, easily seen as red, brown or white areas ranging from on the order of millimeters to centimeters in size, which remain for days or even years after treatment.

[0013] Therefore, there is a need to provide a procedure and apparatus that combine safe and effective treatment for improvement of dermatological disorders with minimum side effects, such as intra procedural discomfort, post procedural discomfort, lengthy healing time, and post procedural infection.

SUMMARY OF THE INVENTION

[0014] It is therefore one of the objects of the present invention to provide an apparatus and method that combines safe and effective treatment for an improvement of dermatological disorders with minimum side effects. Another object of the present invention is to provide an apparatus and method that simultaneously causes multiple individual microscopic wounds to a portion of a target area. Still another object of the present invention is to provide an apparatus and method that successively causes multiple microscopic wounds to a portion of a target area.

[0015] These and other objects can be achieved with an exemplary embodiment of the apparatus and method according to the present invention, in which portions of a target area to be subjected electromagnetic radiation, e.g., heat, light, radio frequency pulses, etc. In accordance with the apparatus and methods of the present invention electromagnetic radiation may be applied invasively or non-invasively to portions of a target area causing fractional wounding of the portions of the target area.

[0016] The electromagnetic radiation may be generated by an electromagnetic radiation source, which is configured to deliver heat, light, radio frequency pulses or the like to a target area to be treated. The exemplary apparatus may include at least one shielding member configured to mask at least one portion of a target area from electromagnetic radiation, in which the shielding members are formed such that a minimal amount of electromagnetic radiation is reflected back towards the electromagnetic radiation source. In yet another advantageous embodiment, the at least one shielding member is a crystal configured to shield at least one portion of a target area from electromagnetic radiation.

[0017] In another exemplary embodiment of the present invention, at least one lens may be used to direct the electromagnetic radiation towards the target area. In still other embodiments, at least one light guide may be used to direct the electromagnetic radiation towards the target area. In an exemplary embodiment, a light guide may be configured with a focusing lens to allow a pulsed non-ablative laser to be used according to the methods of the present invention. For example, a light guide may be configured to direct the electromagnetic radiation into multiple fibers mounted on an applicator and arranged in a random, pseudo random, or predetermined pattern. The applicator may be configured to mount to any standard laser system to allow the laser to be used according to the methods of the present invention.

[0018] In still another exemplary embodiment of the present invention, the tissue is indirectly heated using a distal end of a probe, e.g., a chromophore that absorbs electromagnetic radiation, thereby heating the distal end of the probe. In one advantageous embodiment, chromophore is placed in registration with selected portions of the skin surface of the target area in a pattern corresponding to the desired fractional wounding. Electromagnetic radiation may be applied according to the methods and apparatus of the present invention whereby the chromophore absorbs the electromagnetic radiation and transfer heat to the selected portions of the target area. In some exemplary embodiments, large chromophore particles are statistically distributed and are matched to the anatomical structures of the skin profile. For example, the chromophore may be distributed over unwanted dilated pores by brushing a light absorbing powder over the skin surface to cover the skin with a heterogeneous thickness. Pulsed or scanned electromagnetic radiation may be absorbed by the distributed chromophore to cause fractional wounding of the unwanted dilated pores.

[0019] In yet another exemplary embodiment according to the present invention, invasive apparatus and methods are used to cause fraction wounding of a target area. In an exemplary embodiment of the present invention, an invasive apparatus, including an electromagnetic radiation source is configured to generate electromagnetic radiation, and a delivery device, e.g., delivery optics needles, etc., coupled to the electromagnetic radiation source is configured to penetrate the skin to a desired depth to deliver the

electromagnetic radiation directly to a target area. In other embodiments according to the present invention, multiple delivery optics may be configured to penetrate the skin, e.g., the dermis and/or epidermis, to a desired depth to deliver the electromagnetic radiation directly to multiple selected portions of a target area. For example, an array of light guides may be arranged to simultaneously penetrate the skin at a desired penetration depth to deliver the electromagnetic radiation to the multiple selected portions of the target area.

[0020] In yet still another embodiment of the present invention, pigment particles, e.g., a chromophore, is distributed within the skin and may absorb electromagnetic radiation and cause fractional wounding at a target area. The particles may be removable after treatment, e.g., with a second application of electromagnetic radiation. The pigment particles may be randomly distributed within the skin layers. The distribution may be controlled by using choosing proper concentration and chromophore diameter. In other exemplary embodiments, a delivery apparatus may be used to place the chromophore in a target area. For example, a needle stamp, with a chromophore at the tips of the needles may be used to deliver the chromophore to the surface of the skin or within the skin at a preset depth.

[0021] In still another exemplary embodiment of the present invention, individual radio frequency electrodes, e.g., insulated needles, or an array of radio frequency electrodes may be used to perforate the epidermis to deliver electromagnetic radiation, e.g., heat, to a target area. In one exemplary embodiment, the electrodes are heated to cause fractional wounding to the target area. In other exemplary embodiments, the radio frequency electrodes perforate the skin and radio frequency energy is directly applied to the target area to cause fractional wounding by heating the radio frequency electrodes. In still another exemplary embodiment, the radio frequency electrode is cooled prior to perforating the skin to avoid heating a target area.

[0022] In a further exemplary embodiment of the present invention, electric needles are used to perforate the skin and heat a target area directly. The electric needles may use a pulsed current to heat the insertion portion and cause fractional wounding of the target

area. In still another embodiment, a light fiber or light guide is used to perforate the skin and cause direct heating of a target area. The light guide or light fiber may be injected into the skin in contact with a target area. Light supplied to the tip of the light guide or light fiber may then be used to heat the tip which then heats the surrounding tissue, i.e., the target area, to cause fractional wounding. In a further embodiment, multiple light guides or light fibers may be arranged in an array and used to cause fractional wounding to a target area. A portion of the light guide or light fiber may be configured to absorb energy.

[0023] In a still further embodiment according to the present invention, a needle may be used to mechanically cause fraction wounding of a target area by perforating the skin. In another embodiment, multiple needles may be arranged in an array to perforate desired area. In a further embodiment, the needles may be mounted on a stamp or roll. In still a further embodiment, the needles may be set at a preset depth to perforate the skin. In other embodiments, needles used to physically perforate the target area may be combined with a chromophore, a drug or heat delivery to obtain the benefits of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] For a more complete understanding of the present invention and its advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

[0025] Figs. 1A – 1C show progressive illustrations of an exemplary embodiment of a fractional resurfacing system for conducting various dermatological treatments at various stages of use according to the present invention;

[0026] Figs. 2A and 2B is an exemplary embodiment of a fractional resurfacing system for conducting various dermatological treatments;

[0027] Figs. 3A and 3B show progressive illustrations an exemplary embodiment of the fractional resurfacing system for conducting various dermatological treatments at various stages of use according to the present invention;

[0028] Fig. 4 shows a top view of small individual exposure areas created by the fractional resurfacing system of Figs. 3A and 3B; and

[0029] Fig. 5 shows an exemplary embodiment of a system for monitoring the location of the fractional resurfacing system of Figs. 3A and 3B.

[0030] Throughout the drawings, the same reference numerals and characters, unless otherwise stated, are used to denote like features, elements, components, or portions of the illustrated embodiments. Moreover, while the present invention will now be described in detail with reference to the Figures, it is done so in connection with the illustrative embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] Figs. 1A – 3 illustrate various embodiments of a method and apparatus for fractional resurfacing of a target area of skin. Generally, the exemplary methods and apparatus deliver electromagnetic radiation to a target area on a patient in various patterns, so as to induce thermal injury corresponding to such patterns and involving only a fraction of the target area. The delivery of the electromagnetic radiation to the target area in a predetermined pattern is achieved using either invasive or noninvasive delivery apparatus to generate a specific pattern for affecting superficial and sub-dermal thermal skin injury.

[0032] Fractional resurfacing is defined as the controlled ablation, removal, destruction, damage or stimulation of multiple small (generally less than 1 mm) individual exposure areas of skin tissue with intervening spared areas of skin tissue, performed as a skin treatment. The individual exposure areas may be oval, circular, arced, linear, irregular and/or the like in shape. The spatial scale of fractional resurfacing is chosen to avoid the appearance of various spots or boxes on a macroscopic scale, while still providing effective treatment due to multiple small areas being exposed to greater than a minimal stimulus. For example, removal or photo-thermal destruction of thousands of 0.1 mm diameter individual exposure areas, spaced 0.2 mm apart, and extending into the skin up to a depth of 0.5 mm, is well tolerated and produces effective improvement of photo-aging of skin, without apparent spots and with rapid healing of the affected area. Spared

skin between the individual exposure areas rapidly initiates a wound healing response, which is better tolerated than conventional LSR.

[0033] During the exemplary fractional resurfacing procedure of the present invention, certain portions of the target area remain undamaged, thereby preserving keratinocytes and melanocytes, which serve as a pool of undamaged cells to promote reepithelialization. This procedure differs from the traditional resurfacing procedures, such that the entirety of the target area is damaged. In traditional resurfacing procedures, reepithelialization is generally initiated from the depth of an undamaged follicular epithelium. Because the traditional procedures remove the entire epithelium, an important factor for the time of reepithelialization is the density of follicles. The vellus hair density of the face (439 hairs/cm^2) of the subject is significantly higher than on the back of the subject (85 hairs/cm^2). Therefore, the face of the subject, generally experiences better and faster reepithelialization in comparison to other body areas with a lower hair density.

[0034] The resurfacing of the dark pigmented skin is currently not very frequently performed because of the prolonged repigmentation process. The fractional resurfacing technique improves the repigmentation process but, melanocytes do not migrate well. By sparing certain portions of the target area of the skin, the travel distance of melanocytes can be decreased, thereby reducing the repigmentation time and allowing the resurfacing of all skin types.

[0035] Figs. 1A – 1C illustrate a progressive use of a first exemplary embodiment of a fractional resurfacing system 100 for conducting various dermatological treatments using electromagnetic radiation (“EMR”) and generating a pattern of skin damage of a target area according to the present invention. The system 100 may be used for collagen remodeling, removal of unwanted pigment or tattoo, and/or other dermatological applications. As shown in Figs. 1A-1C, the system 100 includes a case 101, a control module 102, an EMR source 104 and delivery optics 106. The case 101 contains the control module 102, the EMR source 104, and the delivery optics 106. An aperture is provided through a sidewall of the case 101.

[0036] In one exemplary variant of the present invention, the control module 102 can be in wireless communication with the EMR source 104. In another variant, the control module 102 may be in wired communication with the EMR source 104. In another exemplary variant of the present invention, the control module 102 can be located outside of the case 101. In another variant, the EMR source 104 is located outside of the case 101. In still another variant, the control module 102 and the EMR source 104 are located outside of the case 101.

[0037] In one exemplary embodiment, the EMR source 106 is a laser, a flashlamp, a tungsten lamp, a diode, a diode array, and the like. For example, the EMR source 106 may be a CO₂ laser or a Er:YAG laser. In another exemplary embodiment, the EMR source is a radio frequency device capable of outputting signals having frequencies in a desired range. In another exemplary embodiment, the EMR source is capable of outputting an AC or DC electric current.

[0038] The control module 102 provides application specific settings to the EMR source 104. The EMR source 104 receives these settings, and generates EMR based on these settings. The settings can control, *inter alia*, the wavelength and frequency, the pulse duration for each EMR pulse, the fluence of the EMR, the number of EMR pulses, the delay between individual EMR pulses, and the beam profile of the EMR. The energy produced by the EMR source 104 can be optical radiation which is focused, collimated and/or directed by the delivery optics 106. In another embodiment the energy produced by the EMR source 104 can be at radio frequencies. In still another embodiment, the energy produced by the EMR source can be electric current.

[0039] Prior to being used in a dermatological treatment, the system 100 shown in Fig. 1A can be configured by a user. For example, the user may interface with the control module 102 in order to specify the specific settings usable for a particular procedure. The user may specify the wavelength of the EMR, the energy delivered to the skin, the power delivered to the skin, the pulse duration for each EMR pulse, the fluence of the EMR delivered to the skin, the number of EMR pulses, the delay between individual EMR pulses, and the beam profile of the EMR.

[0040] The EMR source 104 may be set to produce a collimated pulsed EMR irradiation with a wavelength ranging from 400 to 11,000 nm, and preferably near 3.0 μm when using an Er:YAG laser and near 10.6 μm when using a CO₂ laser as the EMR source. The collimated pulsed EMR irradiation may be applied having a pulse duration in the range of 1 μs to 10 s, preferably in the range of 100 μs to 100 ms, and more preferably in the range of 0.1 ms to 10 ms, and fluence in the range from 0.01 to 100 J/cm², and preferably in the range from 1 to 10 J/cm². The applied EMR should be able to achieve at least a temperature rise within the targeted areas of the skin that is sufficient to cause thermal damage to the epidermis 110 and/or the dermis 112. The peak temperature sufficient to cause thermal damage in the exposed tissues is time dependant and at least in the range of 45° C to 100° C. For exposure times in the range of 0.1 ms to 10 ms the minimum temperature rise required to cause thermal damage is in the range of approximately 60° C to 100° C. The depth of thermal damage can be adjusted by proper choice of wavelength, fluence per pulse, and number of pulses and invasive or non-invasive delivery apparatus.

[0041] The electromagnetic radiation may be generated by an electromagnetic radiation source 104, e.g., a laser, which is configured to deliver a beam to a portion of a target area 114. In an exemplary embodiment the electromagnetic radiation may directed through a focusing element 201 disposed between the epidermal tissue 110 of the patient and the EMR source 104 to direct electromagnetic radiation toward selected portions of the target area 114. For example, the focusing element 201 may include, but is not limited to, one or more lenses or light guides. In another embodiment, reflecting particles, e.g. large crystals, may be placed between the epidermal tissue 110 of the patient and the EMR source 104 to attenuate the electromagnetic radiation and shield at least one portion of the target area 114 from the electromagnetic radiation.

[0042] In some exemplary embodiments, the focusing element 201 may be part of an applicator 204 that may be detachably attached to the case 101 of the resurfacing system 100. The applicator may be configured with an attachment mount 206 to allow coupling to any standard laser system to allow the laser to be used according to the present invention. The applicator 204 and focusing element 201 may further be designed to

focus the electromagnetic radiation on a specific portion of a patient's body. For example, the focusing element 201 may include light guides configured to direct the electromagnetic radiation into multiple fibers mounted on the applicator 204 and arranged in a random, pseudo random, predetermined or the like pattern. In another exemplary embodiment, the focusing element may include a light guide configured with at least one focusing lens to direct the electromagnetic radiation to selected portions of a target area.

[0043] In some embodiments according to the present invention, the tissue may be indirectly heated by the electromagnetic radiation source 104. In some exemplary embodiments, a chromophore may be placed on the surface of the epidermal tissue 110 of the target area or deposited within the epidermal tissue 110 or dermal tissue 112. The chromophore may absorb the electromagnetic radiation and transfer heat to a portion of the target area 114 sufficient to cause fractional wounding. In some advantageous embodiments, the chromophore is distributed on or in the epidermal or dermal tissue 110, 112 in a pattern corresponding to the desired pattern of fractional wounding, e.g., over a tattooed portion of the skin. In other advantageous embodiments, large chromophore particles are statistically distributed on or in the epidermal or dermal tissue 110, 112 of the patient. In one exemplary embodiment, the large chromophore particles may be matched to the anatomical structure of the skin profile, e.g., the chromophore may be distributed over epidermal tissue 110 that contains dilated pores by brushing a light absorbing powder over the skin surface. The chromophore powder may then cover the epidermal tissue 110 with a heterogeneous thickness so that when the electromagnetic radiation is absorbed heat sufficient to cause fractional wounding is transferred to the unwanted dilated pore.

[0044] In some embodiments according to the present invention, invasive methods may be used to cause fractional wounding of a target area, as shown in Figure 2. In an exemplary embodiment, at least one delivery device 302, e.g., a light guide or a needle, may be used to transfer electromagnetic radiation below the skin surface. In an exemplary embodiment the delivery device 302 may penetrate the epidermal tissue 110 and/or dermal tissue 112 to a desired depth in the epidermis 110 or dermis 112 of a

patient and transfer electromagnetic radiation, e.g., laser light, a radio frequency or heat, to selected portions of a target area. In some embodiments, the electromagnetic energy causes the delivery device to become heated so that the heat causes fractional wounding of a portion of the target area. For example, a laser may be used to transfer electromagnetic radiation to the distal end of a light guide. The distal end of the light guide may absorb the electromagnetic radiation and become sufficiently heated to cause fractional wounding of a portion of target area. In other exemplary embodiments, multiple delivery devices may be arranged to deliver the electromagnetic radiation to a portion of a target area 114. For example, an array of light guides or needles may be arranged to simultaneously penetrate the skin at a desired penetration depth and deliver the electromagnetic radiation to a portion of the target area 114.

[0045] In an exemplary embodiment according to the present invention, pigment particles, e.g., a chromophore, ink, dye and the like, may be distributed within the selected portions of the target area of the epidermis 110 or dermis 112 prior to application of electromagnetic radiation to thereby cause fractional wounding of the selected portions of the target area 114. The pigment particles absorb the electromagnetic radiation causing an increase in the temperature of the pigment particles which damages the selected portions of the target area. In some embodiments, the pigment particles may be randomly distributed within the skin layers, e.g., to cause fractional wounding of a large portion of a target area. In other embodiments, the pigment particles may be controllably distributed by using choosing a preferred particle concentration and diameter. In other embodiments, a delivery apparatus may be used to place the chromophore in a portion of the target area. For example, a needle stamp, with a chromophore at the tips of the needles, may be used to deliver the chromophore to the surface of the skin or within the epidermis 110 or dermis 112 at a preferred depth. In an exemplary embodiment, the chromophore particles are removable after treatment of the target area, e.g., with a second application of electromagnetic radiation of a different wavelength.

[0046] In an exemplary embodiment according to the present invention, the delivery device 302 includes at least one radio frequency electrode, e.g., an insulated needle, an array of insulated needles or the like, used to perforate the epidermis (shown in Fig. 2A)

to deliver electromagnetic radiation (shown by the arrows in Fig. 2b) to selected portions of 114 of the target area. In other embodiments, the radio frequency energy causes the electrodes to become sufficiently heated to cause fractional wounding of a portion of the target area. In a preferred embodiment, the electrodes are cooled prior to perforating the skin, and once the electrodes perforate the epidermis 110, radio frequency pulses are applied to the electrodes, which directly cause fractional wounding of the selected portions of the targeted area. In one example, a radio surgery device may be configured with an insulated needle, e.g. width of about 700-800 μ m and length of about 1400 μ m. The radio surgery device may be set to transfer 8W of power to the insulated needle for 2 seconds, e.g., to transfer 18mJ of energy to a target area with a volume of 100x100x100 μ m, to cause fractional wounding of portions of a target with a diameter of 100 μ m and depths between about 200 to about 400 μ m.

[0047] In another exemplary embodiment of the present invention, the delivery device 302 includes electric needles used to perforate the skin (shown in Fig. 2A) and heat selected portions of a target area directly (shown in Fig. 2B). The electric needles may use a pulsed current to heat a distal portion of the electric needles causing fractional wounding of the selected portion of a target area. In still another embodiment, the delivery device 302 includes at least one a light fiber or light guide, which is used to perforate the at least one skin and cause direct heating of a portion of a target area. For example, the portion of the light guide or light fiber may be configured to absorb EMR. The at least one light guide or light fiber may be injected into the skin in registration with the selected portions of the target area 114. Light supplied to the distal portion of the at least one light guide or light fiber may then be used to heat the tip which in turn heats the surrounding tissue, i.e., the selected portions of the target area 114, causing fractional wounding.

[0048] In an exemplar embodiment according to the present invention, the delivery device 302 is a needle, which is used to mechanically cause fractional wounding of a portion of a target area by physically perforating the skin. In this exemplary embodiment an EMR source 104 is not utilized. In another exemplary embodiment, multiple needles may be arranged in a patterned array to perforate a desired area. In still a further

exemplary embodiment, the multiple needles may be mounted on a stamp or roll. The needle or needles may be set to perforate the skin at a preferred depth to cause fractional wounding of selected portions of a target area. In other embodiments according to the present invention, the needles may be used to physically perforate the skin while chromophores, drugs or heat is delivered to selected portions of the targeted area.

[0049] After the dermatological treatment is completed, the target area of the skin 114 is likely damaged in specific places. The application of the EMR 120 creates a prearranged thermal skin damage 130 in the epidermal tissue 110 and the dermal tissue 112. It should be noted that when applied to the skin surface the thermal damage 130 extends through the epidermal tissue 110 and into the dermal tissue 112 only to a predetermined depth.

[0050] In an exemplary embodiment of the present invention, the thermal skin damage 130 may extend through the epidermal tissue 110 and through the entirety of the dermal tissue 112. In another exemplary embodiment of the present invention, the thermal skin damage 130 may occur principally in the dermal tissue 112 and minor skin damage may occur in the epidermal tissue 110. It should be noted that it is possible that the penetration depths of each of the micro areas of the thermal skin damage 130 may be different from one another or same as one another. This may be because pigment removal or dermal removal can be separately regulated by varying the density of the micro-damaged areas for either the deeper or superficial damages, e.g., dermal remodeling and pigment adjustment, respectively.

[0051] The above described embodiments may be used with a system 700 that may be configured to control the application of the electromagnetic radiation, as shown in Fig. 3A. In particular, the user interfaces with the control module 102 in order to specify the specific settings to be used for a particular procedure. The user may specify the desired damage pattern, the wavelength of the energy produced by the EMR source 104, the intensity of the energy produced, the fluence of the energy produced, the length of time the treatment will take and the pulse duration of the EMR source 104. During the treatment, the translator 708 moves the delivery device, e.g., delivery optics, across sequential portions of the target area of the skin 714 in order to treat the entire target area.

The target area is treated when the system 700 delivers EMR to individual exposure areas of the target area. The individual exposure areas may be targeted serially and/or in parallel. When one of the portions of the target area has been completely treated, the system 700 is moved to the next portion of the target area. For example, the system 700 is moved at the completion of irradiation of each portion of the target area until the desired skin surface damage pattern is achieved for the entire area. The system 700 can be moved using discrete movements from one sequential portion to the next, i.e., stamping mode, or using continuous movement across the skin surface, i.e., continuous scanning mode. In either case, the movement of the delivery optics, driven by the translator 708, is controlled by the control unit 102 and likely matched with the movement of the system 700 by the operator (or the user) in order to provide the desired surface damage pattern to the target area of the skin 714.

[0052] In an exemplary embodiment of the present invention, the system 700, while operating in the continuous scanning mode, can deliver EMR to a particular individual exposure area 716, then, after exposure of such area 716, translate along the skin of the target area, and thereafter deliver a further EMR to another individual exposure area 716 separated from the previous particular individual exposure area 716 by non-irradiated region. In another exemplary embodiment of the present invention, the system 700, while operating in the continuous scanning mode, can deliver EMR to a particular group of individual exposure areas 716, for example the top row of individual exposure areas 716 (shown in Fig. 3), then, after exposure of such areas 716, translate along the skin of the target area, and deliver a further EMR to another group of individual exposure areas 716, for example the second row of individual exposure areas 716 (shown in Fig. 3), separated from the particular group of individual exposure areas 716 by non-irradiated areas.

[0053] In an exemplary embodiment of the present invention, the system 700 includes a position sensor, which is in communication with the control module 702. The position sensor is capable of sensing the relative velocity as between the skin 114 and the case 701. The position sensor can be an optical mouse, wheels, track ball, conventional mouse, and the like.

[0054] In another exemplary embodiment of the present invention, the system 700 targets individual exposure areas 716 one at a time. Administering EMR to the individual exposure areas 716 one at a time decreases the amount of pain experienced by the subject. A time period of 50 milliseconds may be provided between each administration of EMR to each of the individual exposure areas 716. Thereby controlling the amount of pain experienced by the subject and avoiding bulk heating of the tissue targeted by the system 700. In still another exemplary embodiment of the present invention, the system 700 targets a predetermined number of individual exposure areas 716 at a time. Limiting the number of predetermined target areas 716 targeted at one time limits the amount of pain experienced by a patient. Targeting a large number of individual exposure areas 716 at one time requires targeting a collectively large area of skin, which excites many nerve endings simultaneously, therefore causing the subject a proportionally large amount of pain. Targeting fewer individual exposure areas 716 causes a subject less pain, but causes a procedure to take longer.

[0000] In a further exemplary embodiment of the present invention, the system 700 creates individual exposure areas 716 having a separation distance between each of the individual exposure areas 716 of approximately at least 125 μm and at most 500 μm , preferably, the separation distance is approximately at least 250 μm .

[0056] In one embodiment, of the present invention the optically transparent plate 709 can be composed of sapphire or quartz. In another embodiment of the present invention, the system 700 can be moved multiple times over the same portion of the skin 714 until the desired fill factor is achieved. In yet another embodiment, multiple procedures can be performed to achieve the desired effect.

[0057] During the dermatological procedure, the EMR source 704 emits EMR having a wavelength in the range of 400 - 12,000 nm. Preferably the EMR has a wavelength in one of the following ranges: 1,300 to 1,600 nm, 1,850 to 2,100 nm, 2,300 to 3,100 nm and around 10,640 nm. Depending on the application, a single wavelength or a combination of different wavelengths may be utilized. The EMR source 704 can be a diode laser, a fiber laser, a solid state laser, a gas laser, and the like. The pulse duration

can range from 100 μ s to 100 ms, and preferably in the range from 500 μ s to 15 ms, and more preferably in the range from 1.5 ms to 5 ms. The energy density per pulse within an individual exposure area 716 may be in the range of 0.1 to 100 J/cm², preferably 1 to 32 J/cm², and more preferably 1.5 to 3 J/cm². The energy per pulse within an individual exposure area 716 may be in the range of 1 mJ and 10 mJ, and preferably 5 mJ.

[0000] In an exemplary embodiment of the present invention, the EMR source 704 is a 1.5 μ m laser system.

[0059] After the dermatological treatment is completed, the target area of the skin 714 is damaged in a specific pattern. The application of EMR creates the thermal skin damage in an epidermis 710 and a dermis 712 of the skin 714. The radiation provided by the EMR source 704 is delivered to the skin 714 within multiple small individual exposure areas 716, shown in Fig. 3B, through the delivery optics 706. The delivery optics 706 can deliver multiple individual beams across the target area of the skin surface.

[0060] Fig. 4 illustrates a top view of the small individual exposure areas 716 of the epidermis. The shape of the individual exposure areas 716 may be circular (shown in Fig. 4), elliptical, rectangular, linear or irregular with a lateral diameter of the smallest dimension in the range of 1 – 500 μ m. The fill factor of the target area can be approximately 20 – 40%.

[0061] The system 700 can create multiple individual exposure areas 716 through heating, ablation, removal, photothermal coagulation, thermal necrosis and/or stimulation. The multiple areas can be exposed sequentially or simultaneously. Sequential exposure may be achieved by scanning or moving an energy source which may be either pulsed, shuttered or continuous. Simultaneous exposure can be achieved, for example, by an array of sources or a multi-array of lenses. The array of sources may be a uni-dimensional array, a bi-dimensional array or the like. The array can be moved relative to the skin, and one or multiple passes of treatment can be performed in a target area.

[0062] Fig. 5 illustrates an exemplary embodiment of a monitoring system 900 according to the present invention. The monitoring system 900 tracks the movement of the system 700, and feeds such positional information to the control module 102 (shown in Figs. 3A-B). The control module 102 utilizes this information to appropriately instruct the translator 708 (shown in Figs. 3A – 3B) to position the delivery optics 706 (shown in Figs. 3A-3B), such that the appropriate damage pattern is achieved across the target area of the skin 714. The monitoring system 900 may use a computer 902, a mouse 904, and a charge coupled device (“CCD”) camera 906. In particular, the computer 902 receives the positional information about the system 700 from the CCD camera 906. The computer then updates the control module 702 based on this positional information as to the current position of the system 700. The control module 702 utilizes this information to cause the system 700 to create the appropriate damage pattern on the skin 714 within the target area. In addition, the monitoring system can utilize additional motion detecting devices, including, wheels or any other motion sensor.

[0063] The shape of the individual exposure areas 716 and the relative pattern represented by all of the individual exposure areas 716 may vary. The individual exposure areas 716 can have a circular, elliptical, rectangular, linear or irregular shape. The average distance between individual regions of unexposed skin surface may be in the range between 10 to 2000 μm , and preferably in the range of 100 to 500 μm . The macroscopic pattern of the individual exposure areas 716 may be a field of uniformly distributed individual exposure areas 716 with constant spacing throughout the target area, randomly distributed individual exposure areas 716 within the target area, and/or regularly distributed individual exposure areas 716 with constant average spacing with randomly shifted location. In particular, having regularly distributed individual exposure areas 716 with constant average spacing with randomly shifted location may be useful to minimize undesirable effects, which may occur during multiple treatments. Such multiple treatments are utilized to cover the entire area as homogeneously as possible by the individual exposure areas 716 during the course of multiple treatments. However, uniformly distributed individual exposure areas 716 with constant spacing throughout the target area may create unwanted spatial distributions similar to moiré patterns, resulting in spatial interference macroscopic patterns generated with a distance in between the

areas of exposure which have a significant spatial period. In order to minimize the occurrence of moiré patterns, a randomized shift within the range of 10 to 50% of the average distance between individual exposure areas 716 during a single scan may be utilized.

[0064] The treatment can be performed in by a single treatment covering the skin surface with a specific surface damage pattern, or by multiple treatments either performed at the same visit or during different treatment visits. Individual or multiple exposures can be used to achieve the appropriate thermal damage in particular individual exposure areas 716.

[0065] Fractional resurfacing may cause portions of the epidermis to be thermally damaged or ablated, thereby reducing the efficacy of the barrier function of the epidermis and in particular decreasing the stratum corneum. This facilitates the delivery of drugs or specific substances to the dermis and epidermis which can either enhance the effects of the treatment, or decrease the side effects caused by partial damage of the epidermis and/or dermis. Groups of drugs and substances, which may enhance the efficacy of skin remodeling include growth factors, collagen byproducts, collagen precursors, hyaluronic acid, vitamins, antioxidants, amino acids and supplemental minerals among others. Groups of drugs and substances, which may decrease side effects, can be steroidal anti-inflammatory drugs, non-steroidal anti-inflammatory drugs, antioxidants, antibiotics, antiviral drugs, antiyeast drugs and antifungal drugs.

[0066] In an exemplary embodiment of the present invention, the vitamins that are used may be vitamin C and/or vitamin E. The supplemental minerals used are copper and zinc. The antioxidants can be vitamin C and/or vitamin E.

[0067] In a clinical observation, enhanced wound healing was observed for fractional resurfacing as compared to conventional resurfacing. The forearm skin of a white, male Caucasian was exposed to pulsed CO₂ laser radiation with identical settings of the illuminating laser beam with a beam diameter of approximately 3 mm, a Coherent Ultra Pulse Laser, CPG handpiece, at approximately 300mJ/pulse. One area was exposed to the laser beam without benefit of a mask while another area was partially shielded by a

cooled mask. More pronounced erythema was evident at the conventionally resurfaced test site as compared to the fractionally resurfaced test site.

[0068] The fill factor of the target area may be monitored by sensing the electrical impedance of the skin from a location on the skin within the target area to a remote location on the skin outside of the target area during or after treatment. An indicator capable of staining the defects in the stratum corneum (for example, trypan glue) or transdermal waterloss are effective indicators of the fill factor of the target area.

[0069] The foregoing merely illustrates the principles of the invention. Various modifications and alterations to the described embodiments will be apparent to those skilled in the art in view of the teachings herein. It will thus be appreciated that those skilled in the art will be able to devise numerous techniques which, although not explicitly described herein, embody the principles of the invention and are thus within the spirit and scope of the invention.

WHAT IS CLAIMED:

1. An apparatus for treating dermatological conditions, comprising:
a delivery module configured to direct electromagnetic radiation generated by an electromagnetic radiation source to a predetermined area within a target area of skin, wherein the predetermined area is located in a location relative to the delivery module, and wherein the electromagnetic radiation is adapted to cause thermal damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin; and an adaptor coupled to the delivery module capable of providing the delivery module in communication with an electromagnetic radiation source.
2. The apparatus of claim 1, wherein the delivery module is capable of perforating the skin to a predetermined depth.
3. The apparatus of claim 1, wherein the electromagnetic radiation source comprises an ablative laser.
4. The apparatus of claim 1, wherein the electromagnetic radiation source comprises one of a diode laser, a fiber laser, a solid state laser and a gas laser.
5. The apparatus of claim 1, wherein the electromagnetic radiation source comprises a radio frequency generator.
6. The apparatus of claim 1, wherein the electromagnetic radiation source comprises an electric power supply.
7. The apparatus of claim 1, wherein the delivery module comprises a beam collimator.
8. The apparatus of claim 1, wherein the delivery module comprises optical components.
9. The apparatus of claim 1, wherein the delivery module comprises a light guide or fiber.
10. The apparatus of claim 9, wherein the delivery module comprises:
a proximal portion configured to transmit at least one light pulse; and

a distal portion, wherein the distal portion increases in temperature at least due to the at least one light pulse causing thermal damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

11. The apparatus of claim 9, wherein the delivery module is configured to transmit at least one light pulse wherein the at least one light pulse causes damage to at least one of the epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

12. The apparatus of claim 1, wherein the delivery module comprises a needle.

13. The apparatus of claim 12, wherein the needle is insulated.

14. The apparatus of claim 12, wherein the needle is heated causing thermal damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

15. The apparatus of claim 12, wherein the needle is capable of transmitting at least one radio frequency pulse wherein the at least one radio frequency pulse heats the needle to cause thermal damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

16. The apparatus of claim 12, wherein the needle is capable of transmitting at least one radio frequency pulse wherein the at least one radio frequency pulse directly causes damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

17. The apparatus of claim 12, wherein the needle is cooled before insertion into at least one of the epidermal tissue and dermal tissue within the target area of the skin.

18. The apparatus of claim 12, wherein the needle perforates the skin to cause damage to at least one of the epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

19. The apparatus of claim 1, wherein the delivery module comprises particles.

20. The apparatus of claim 19, wherein the particles comprise a chromophore.

21. The apparatus of claim 19, wherein the particles absorb electromagnetic radiation

to produce heat sufficient to cause damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

22. The apparatus of claim 19, wherein the particles are placed randomly, semi-randomly or in a predetermined arrangement on the surface of a skin surface.

23. The apparatus of claim 19, wherein the particles are placed randomly, semi-randomly or in a predetermined arrangement in at least one of the epidermal tissue and dermal tissue.

24. The apparatus of claim 23, wherein the particles may be removed from the at least one of the epidermal tissue and dermal tissue.

25. The apparatus of claim 1, wherein the adaptor is configured to provide electromagnetic radiation to a specific area of skin of a patient.

26. The apparatus of claim 1, wherein the adaptor is configured to mount to multiple electromagnetic radiation source.

27. The apparatus of claim 1, wherein the dermal tissue of the skin of the plurality of spatially separated individual exposure areas is damaged down to a predetermined depth thereof.

28. The apparatus of claim 1, wherein the plurality of spatially separated individual exposure areas cover at least five percent of the target area and at most sixty percent of the target area.

29. The apparatus of claim 1, wherein an average distance between each of the plurality of spatially separated individual exposure areas is at least 10 μm and at most 2000 μm .

30. The apparatus of claim 1, wherein each of the plurality of spatially separated individual exposure areas have a diameter of approximately 0.1 mm.

31. The apparatus of claim 1, wherein each of the plurality of spatially separated individual exposure areas have a lateral diameter of a smallest dimension of at least 1 μm and at most 500 μm .

32. The apparatus of claim 1, wherein a first one of the plurality of spatially separated

individual exposure areas is exposed to electromagnetic radiation associated with a first set of parameters and a second one of the plurality of spatially separated individual exposure areas is exposed to electromagnetic radiation associated with a second set of parameters.

33. The apparatus of claim 1, wherein at least two of the individual exposure areas are separated from one another by an unaffected area.

34. The apparatus of claim 32, wherein the at least two of the individual exposure areas are separated from one another by at least approximately 125 μm .

35. The apparatus of claim 32, wherein the at least two of the individual exposure areas are separated from one another by at most approximately 500 μm .

36. The apparatus of claim 1, wherein one of at least one hundred of the individual exposure areas within an area of a square centimeter is separated from another one of the at least one hundred of the individual exposure areas by an unaffected area.

37. The apparatus of claim 1, wherein one of at least one thousand of the individual exposure areas within an area of a square centimeter is separated from another one of the at least one thousand of the individual exposure areas by an unaffected area.

38. A method for treating skin, comprising:
controlling an electromagnetic radiation source to generate an electromagnetic radiation;

causing the electromagnetic radiation to be applied to skin through a delivery module configured to direct the electromagnetic to a predetermined area within a target area of skin, wherein the predetermined area is located in a location relative to the delivery module, and wherein the electromagnetic radiation is adapted to cause thermal damage to at least one of an epidermal tissue and a dermal tissue of the predetermined area; and wherein an adaptor is coupled to the delivery module providing the delivery module in communication with an electromagnetic radiation source.

39. The method of claim 38, wherein the delivery module is capable of perforating the skin to a predetermined depth.

40. The method of claim 38, wherein the electromagnetic radiation source comprises

an ablative laser.

41. The method of claim 38, wherein the electromagnetic radiation source comprises one of a diode laser, a fiber laser, a solid state laser and a gas laser.

42. The method of claim 38, wherein the electromagnetic radiation source comprises a radio frequency generator.

43. The method of claim 38, wherein the electromagnetic radiation source comprises an electric power supply.

44. The method of claim 38, wherein the delivery module comprises a beam collimator.

45. The method of claim 38, wherein the delivery module comprises optical components.

46. The method of claim 38, wherein the delivery module comprises a light guide or fiber.

47. The method of claim 46, wherein the delivery module comprises:

a proximal portion capable of transmitting at least one light pulse; and

a distal portion, wherein the distal portion increases in temperature at least due to the at least one light pulse causing thermal damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

48. The method of claim 46, wherein the delivery module is capable of transmitting at least one light pulse wherein the at least one light pulse directly causes damage to at least one of the epidermal tissue and the dermal tissue of the predetermined area within the target area of the skin.

49. The method of claim 38, wherein the delivery module comprises a needle.

50. The method of claim 49, wherein the needle is insulated.

51. The method of claim 49, wherein the needle is heated to cause thermal damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

52. The method of claim 49, wherein the needle is capable of transmitting at least one radio frequency pulse wherein the at least one radio frequency pulse heats the needle to cause thermal damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

53. The method of claim 49, wherein the needle is capable of transmitting at least one radio frequency pulse wherein the at least one radio frequency pulse directly causes damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

54. The method of claim 49, wherein the needle is cooled before inserted in the epidermal tissue or dermal tissue within the target area of the skin.

55. The method of claim 49, wherein the needle perforates the skin to cause damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

56. The method of claim 38, wherein the delivery module comprises particles.

57. The method of claim 56, wherein the particles comprise a chromophore.

58. The method of claim 56, wherein the particles absorb electromagnetic radiation to produce heat sufficient to cause damage to epidermal tissue and dermal tissue of the predetermined area within the target area of the skin.

59. The method of claim 56, wherein the particles are placed randomly, semi-randomly or in a predetermined arrangement on the surface of a skin surface.

60. The method of claim 56, wherein the particles are placed randomly, semi-randomly or in a predetermined arrangement in at least one of the epidermal tissue and dermal tissue.

61. The method of claim 60, wherein the particles may be removed from the at least one of the epidermal tissue and dermal tissue.

62. The method of claim 38, wherein the adaptor is configured to provide electromagnetic radiation to a specific area of skin of a patient.

63. The method of claim 38, wherein the adaptor is configured to mount to multiple

electromagnetic radiation source.

64. The method of claim 38, wherein the dermal tissue of the skin of the plurality of spatially separated individual exposure areas is damaged down to a predetermined depth thereof.

65. The method of claim 38, wherein the plurality of spatially separated individual exposure areas cover at least five percent of the target area and at most sixty percent of the target area.

66. The method of claim 38, wherein an average distance between each of the plurality of spatially separated individual exposure areas is at least 10 μm and at most 2000 μm .

67. The method of claim 38, wherein each of the plurality of spatially separated individual exposure areas have a diameter of approximately 0.1 mm.

68. The method of claim 38, wherein each of the plurality of spatially separated individual exposure areas have a lateral diameter of a smallest dimension of at least 1 μm and at most 500 μm .

69. The method of claim 38, wherein a first one of the plurality of spatially separated individual exposure areas is exposed to electromagnetic radiation associated with a first set of parameters and a second one of the plurality of spatially separated individual exposure areas is exposed to electromagnetic radiation associated with a second set of parameters.

70. The method of claim 38, wherein at least two of the individual exposure areas are separated from one another by an unaffected area.

71. The method of claim 65, wherein the at least two of the individual exposure areas are separated from one another by at least approximately 125 μm .

72. The method of claim 65, wherein the at least two of the individual exposure areas are separated from one another by at most approximately 500 μm .

73. The method of claim 38, wherein one of at least one hundred of the individual exposure areas within an area of a square centimeter is separated from another one of the

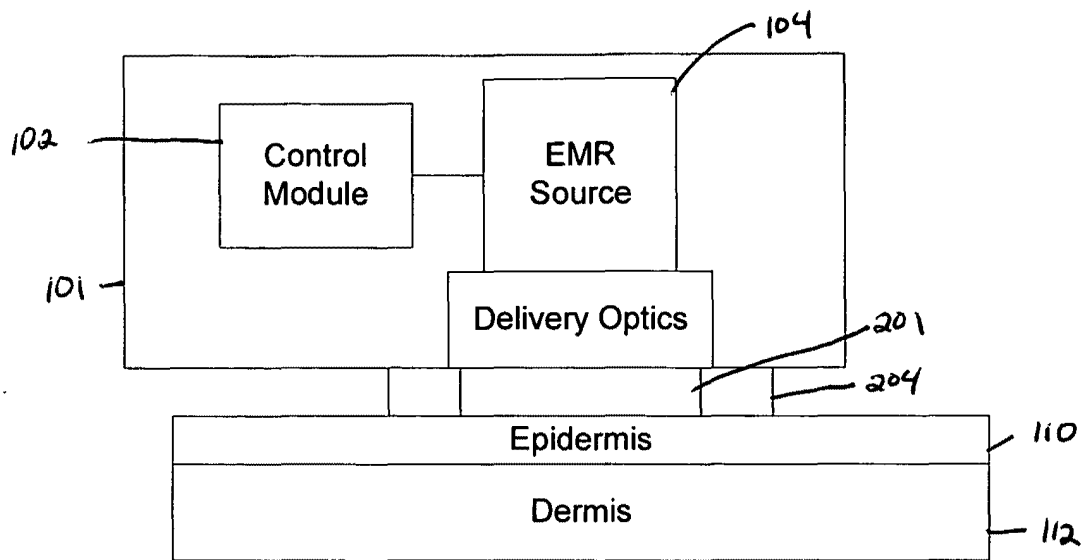
at least one hundred of the individual exposure areas by an unaffected area.

74. The method of claim 38, wherein one of at least one thousand of the individual exposure areas within an area of a square centimeter is separated from another one of the at least one thousand of the individual exposure areas by an unaffected area.

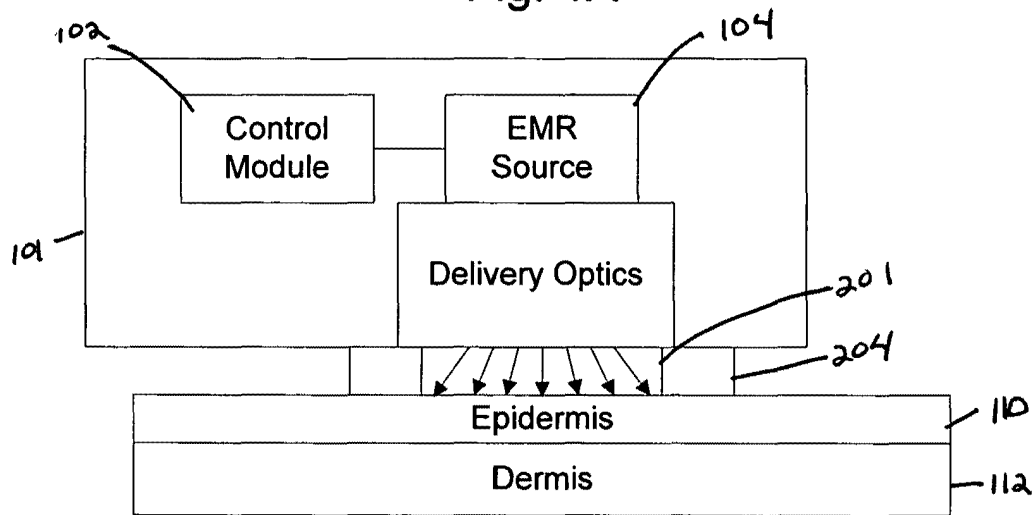
75. A software arrangement for treating skin, wherein the software arrangement, when executed by a processing arrangement, is configured to cause the processing arrangement to execute the steps comprising:

- controlling an electromagnetic radiation source to generate an electromagnetic radiation;

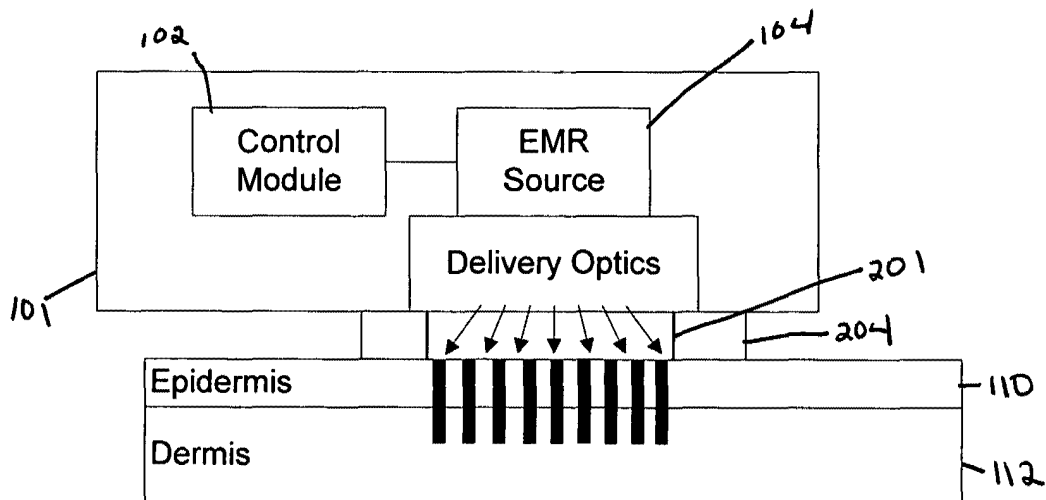
- causing the electromagnetic radiation to be applied to skin through a delivery module configured to direct the electromagnetic to a predetermined area within a target area of skin, wherein the predetermined area is located in a location relative to the delivery module, and wherein the electromagnetic radiation is adapted to cause thermal damage to at least one of an epidermal tissue and a dermal tissue of the predetermined area; and wherein an adaptor is coupled to the delivery module providing the delivery module in communication with an electromagnetic radiation source.



100
Fig. 1A



100
Fig. 1B



100
Fig. 1C

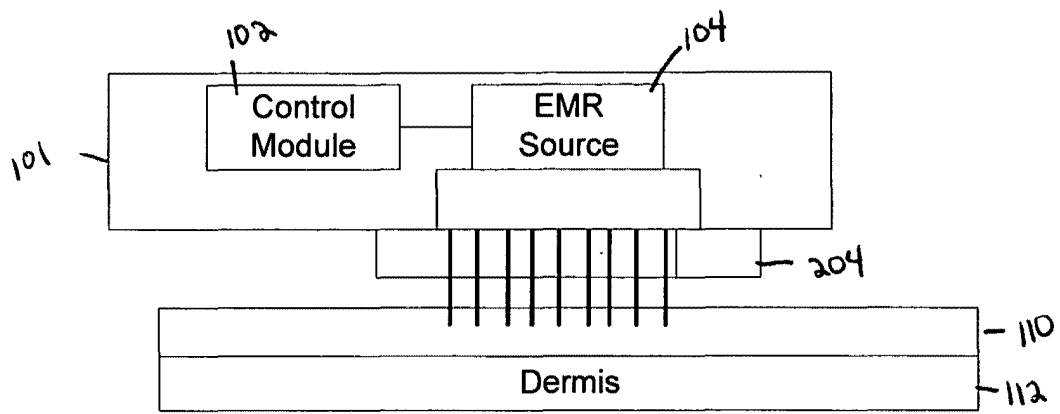


Fig. 2A

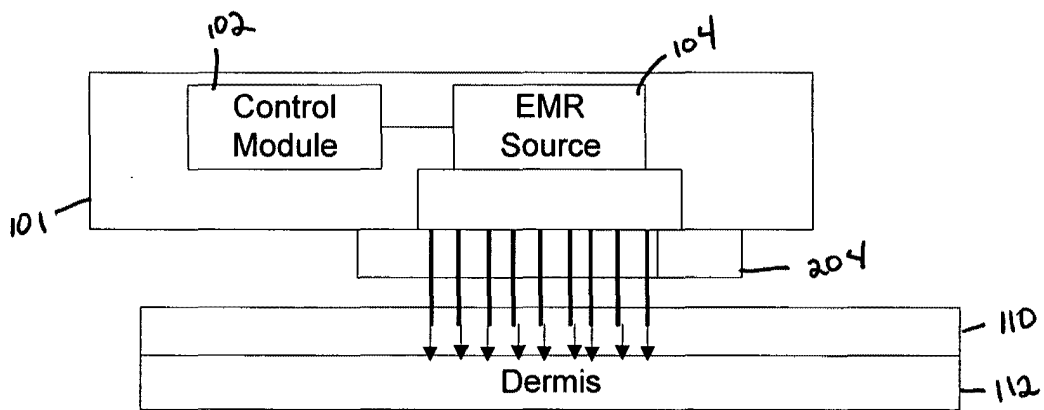


Fig. 2B

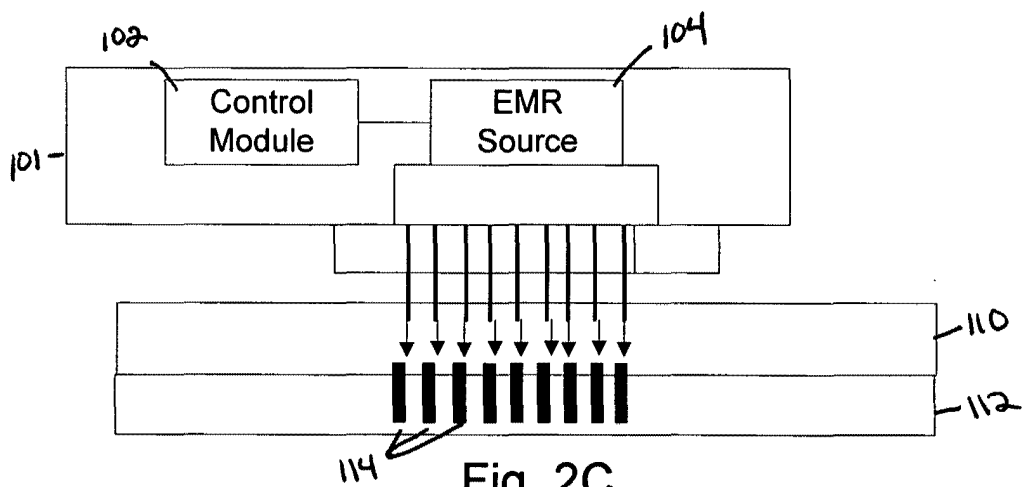
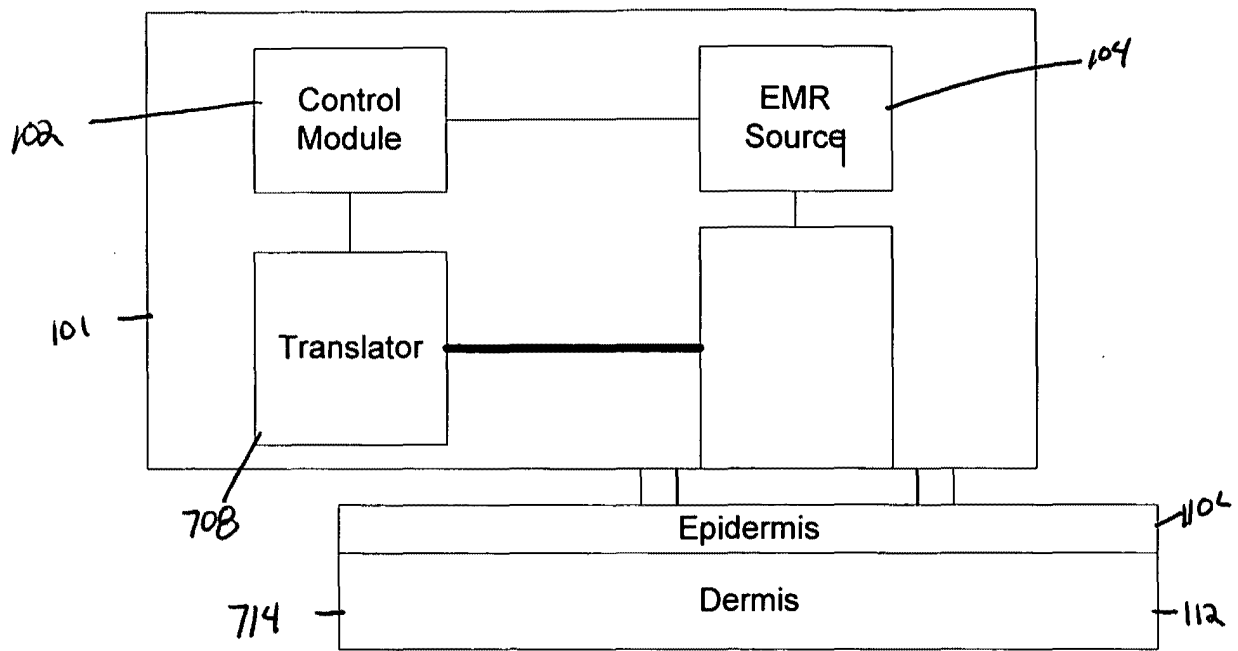
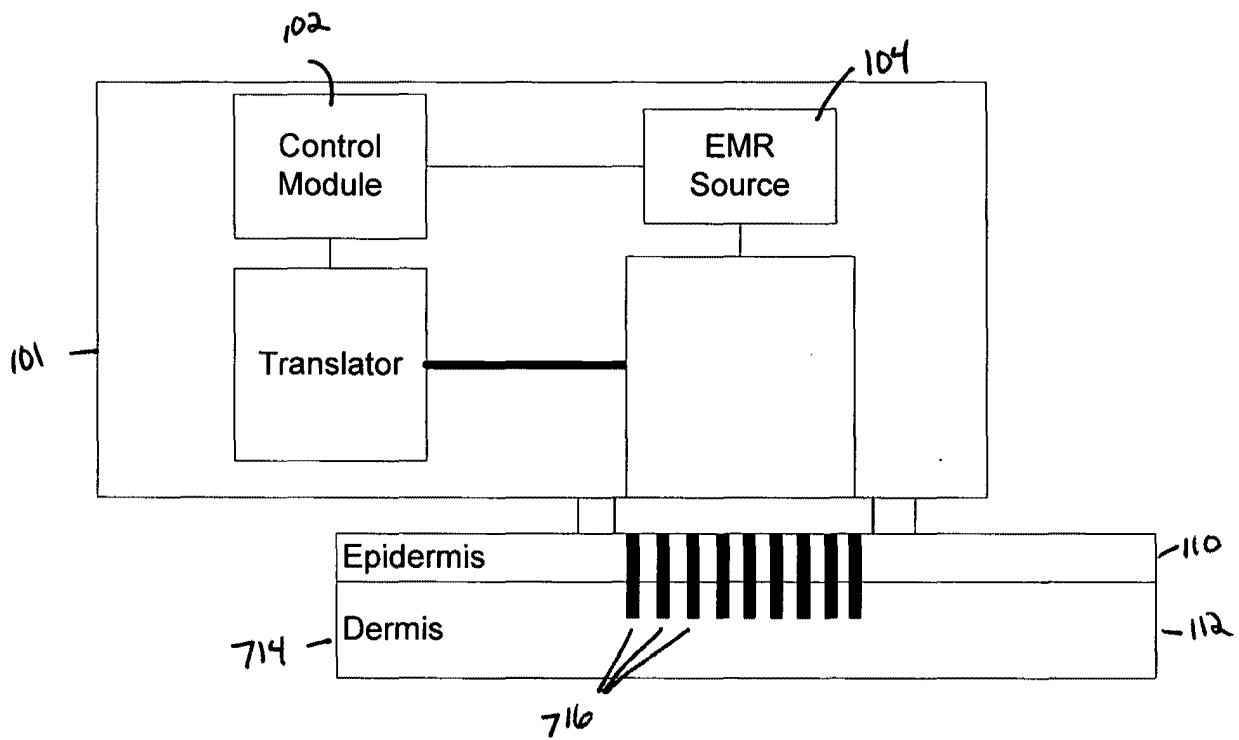


Fig. 2C



700
Fig. 3A



700
Fig. 3B

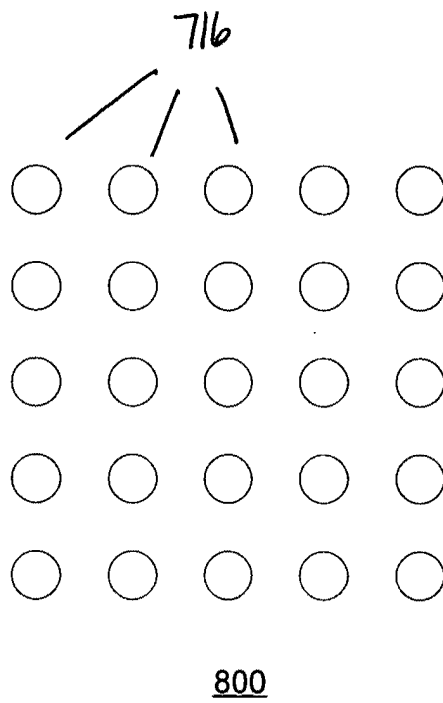


Fig. 4

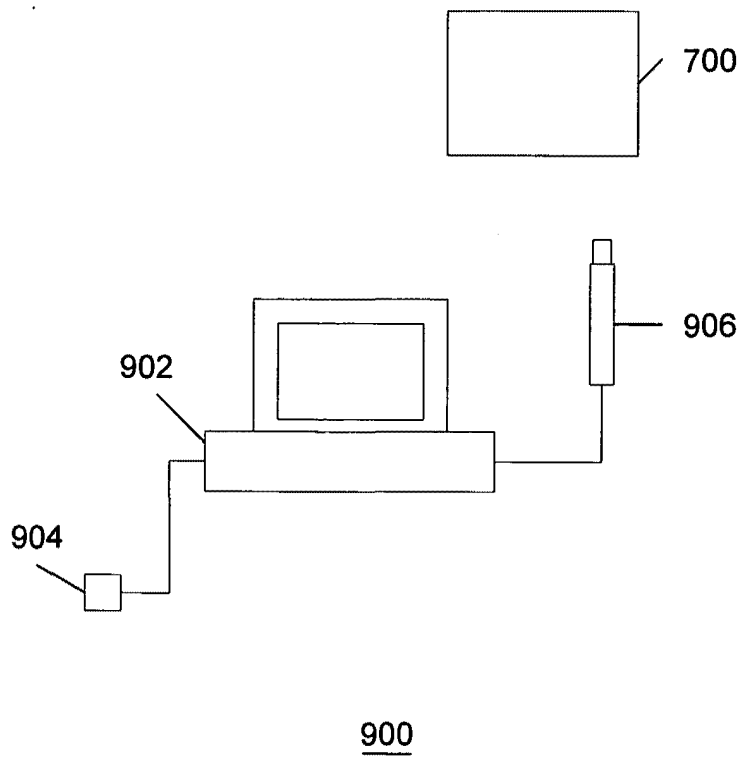


Figure 5