insertion. However, the penetration of microneedles to precise levels within the skin tissue and with good reproducibility is often a challenging task. Therefore, unlike the application of traditional patch-based delivery systems, some existing MTSs require the assistance of external energy to ensure efficient and reproducible penetration of microneedles into biological tissue at desired depths. This assistance can be achieved by utilizing an apparatus device, which can either be used after positioning the microneedle array on the skin surface, or the apparatus device can be integrated with an array of microneedles and, upon activation, can deliver the microneedle array into the skin. The microneedles help to create microchannels in the skin, which in some embodiments, can facilitate delivering an active ingredient. In some constructions, active component(s) may be coated on the microneedle array and delivered directly through the skin when the stratum corneum is punctured by the microneedles. One advantage of MTS systems over other skin treatment methods is a reduced-pain mode of delivery.

SUMMARY

Some embodiments of the present disclosure provide a microneedle injection apparatus that can include a housing having a base and a cavity that extends through the base to define an opening in the base, wherein the base of the housing is configured to be positioned toward a skin surface. The apparatus can further include a microneedle array comprising a first side comprising a plurality of microneedles. The apparatus can further include a microneedle array holder configured to hold a microneedle array and located in the housing. The microneedle array holder can be movable with respect to the opening in the base of the housing between (i) a retracted position in which the microneedle array is recessed within the housing such that the microneedle array does not contact the skin surface when the apparatus is positioned on the skin surface and the microneedle array is coupled to the microneedle array holder, and (ii) an extended position in which at least a portion of the microneedle array is positioned to contact the skin surface via the opening when the apparatus is positioned on the skin surface and the microneedle array is coupled to the microneedle array holder. The apparatus can further include a cover configured to be positioned to cover the opening in the base of the housing. The cover can include (i) a first portion configured to cover at least a portion of the base of the housing adjacent the opening, and (ii) a second portion configured to be received in the cavity of the housing and further configured to cover the plurality of microneedles on the microneedle array when the microneedle array holder is in the retracted position. The housing can further include a protrusion that defines the base of the housing, and the first portion of the cover can include a recess dimensioned to receive the protrusion of the housing. The cover can be configured to abut a portion of the housing from which the protrusion projects to inhibit the cover from pressing the actuator when the cover is coupled to the microneedle injection apparatus.

Other features and aspects of the present disclosure will become apparent by consideration of the detailed description and accompanying drawings.

What is claimed is:

1. A microneedle injection apparatus comprising:

a housing having a base and a cavity that extends through the base to define an opening in the base, wherein the base of the housing is configured to be positioned toward a skin surface;

a microneedle array comprising a first side comprising a plurality of microneedles;

a microneedle array holder configured to hold a microneedle array and located in the housing, the microneedle array holder movable with respect to the opening in the base of the housing between

a retracted position in which the microneedle array is recessed within the housing such that the microneedle array does not contact the skin surface when the apparatus is positioned on the skin surface and the microneedle array is coupled to the microneedle array holder, and

an extended position in which at least a portion of the microneedle array is positioned to contact the skin surface via the opening when the apparatus is positioned on the skin surface and the microneedle array is coupled to the microneedle array holder; and

a cover configured to be positioned to cover the opening in the base of the housing, the cover including

a first portion configured to cover at least a portion of the base of the housing adjacent the opening, and

a second portion configured to be received in the cavity of the housing and further configured to cover the plurality of microneedles on the microneedle array when the microneedle array holder is in the retracted position; and

wherein the housing includes a protrusion that defines the base of the housing, and wherein the first portion of the cover includes a recess dimensioned to receive the protrusion of the housing; and

wherein the cover is configured to abut a portion of the housing from which the protrusion projects to inhibit the cover from pressing the actuator when the cover is coupled to the microneedle injection apparatus.

2. The apparatus of claim 1, wherein the cover is configured to be coupled to the housing.

3. The apparatus of claim 1 or 2, wherein at least a portion of the base of the housing adjacent the opening includes a skin-contact adhesive, and wherein the cover is configured to cover at least the portion of the base including the skin-contact adhesive.

4. The apparatus of any of claims 1-3, wherein at least a portion the base of the housing adjacent the opening includes a skin-contact adhesive and further comprising a release liner coupled to the adhesive on the base of the housing, the cover configured to cover at least the portion of the base of the housing including the release liner.

opening in the base of the housing and defines an actuator base configured to be coupled to the skin surface, and wherein the cover is configured to cover at least the actuator base, wherein the cover is removable from the remainder of the apparatus, and wherein when the cover is coupled to the apparatus, the cover is positioned to prevent the actuator from being moved to its second position.

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