

systems, however, the drug is included inside the hydrogel-forming microneedle patch rather than in an external reservoir, thus potentially limiting the quantity of drug that can be delivered. The use of a separate drug reservoir, paired with a drug-free hydrogel-forming array, provides flexibility in the formulation of the attached drug reservoir, which inherently confers greater loading capacity than the methods employed in drug loading of an array containing the drug within itself.

Conceptualized and created for transdermal drug delivery, hydrogel-forming microneedles have also found application in other healthcare scenarios. In only a slight aside, in the field of photodynamic therapy, a hydrogel-forming microneedle array composed of 20% w/w PMVE/MA, cross-linked with 6% w/w glycerol, was shown to enhance delivery of the porphyrin precursor 5-aminolevulinic acid and a preformed photosensitizer, meso-tetra (N-methyl-4-pyridyl) porphine tetra tosylate. Moving away from drug delivery completely, however, Yang et al. (2013) have demonstrated that their advanced microneedle system could be used in skin graft adherence, as illustrated in Fig. 5. Biphasic, conical shaped microneedles composed of a non-swelling polystyrene core and a polystyrene-*block*-poly(acrylic acid) swellable tip were inserted into tissue with minimal force and once in place, displayed enhanced tissue adhesion strength in comparison to staples, which are conventionally used in skin graft adherence. Furthermore, there is the opportunity for the swelling tips to be loaded with therapeutic agents, in order to facilitate both local drug delivery and tissue adhesion.

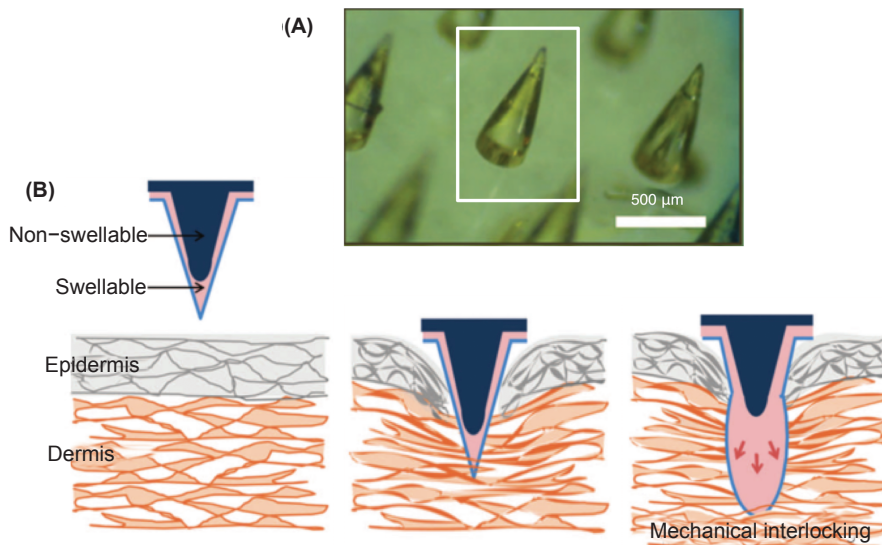


Fig. 5. Concept of the bio-inspired hydrogel microneedle adhesive. Microneedle image showing the poly(styrene)-block-poly(acrylic acid) swellable tip, clearly distinguishable from the non-swelling polystyrene core (A). Illustration showing mechanical interlocking of a water-responsive shape-changeable microneedle, following penetration into tissue (B).