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Frog-inspired programmable nano-architectures for skin patches and medical applications

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Nanoscale observation of attachment systems of animals has revealed various exquisite multiscale architectures for essential functions such as gecko's locomotion, beetles' wing fixation, octopuses' sucking and crawling. In particular, the hierarchical 3-dimensional hexagonal nano-architectures in the tree frog's adhesion is known to have the capability of the enhancement of adhesion forces on the wet or rough surfaces due to the conformal contacts against rough surfaces and water-drainable micro channels. Here, we report that tree frog-inspired patches using unique artificial 3-dimensional hexagonal structures can be exploited to form reversibly enhanced adhesion against various highly curved and rough surfaces in dry and wet condition. To investigate the adhesion effect of micro-channels, we changed the arrangement of microstructure and spacing gaps between micro-channels. In addition, we introduced the 3-dimensional hexagonal hierarchical architectures to artificial patches to enhance to conformal contacts on the various rough surfaces such as skin and organs. Using the robust adhesion properties, we demonstrated the self-drainable and comfortable skin-attachable devices which can measure EKG (electrokardiogramme) for in-vitro diagnostics. As a result, bio-inspired programmable nano-architectures can be applied in versatile devices such as, medical patches, skin-attachable electronics etc., which would shed light on future smart, directional and reversible adhesion systems.

Keywords: Frog-inspired, Skin patch, Adhesion, channel, EKG

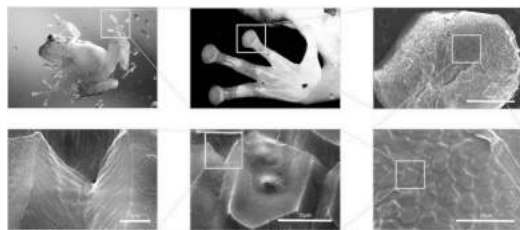


Fig. 1. SEM images of micro-channels of tree frog toe pads

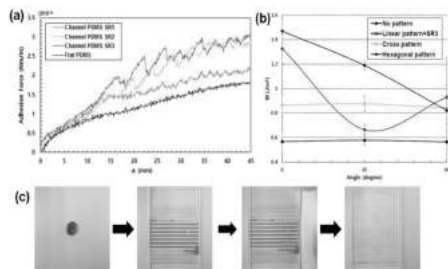


Fig. 3. (a) Adhesion of micro-channels against peel-off force on the glass substrate from 1 to 3 Space ratio (SR), (b) Directional adhesion of various shape channels, (c) Water excreting test with linear patterned channel patches

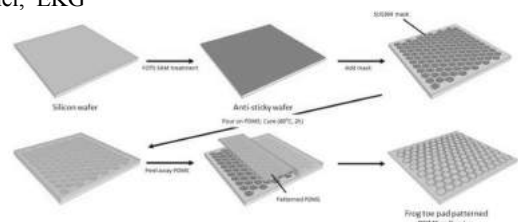


Fig. 2. Fabrication of various bio-inspired micro-channels with simple moulding technique

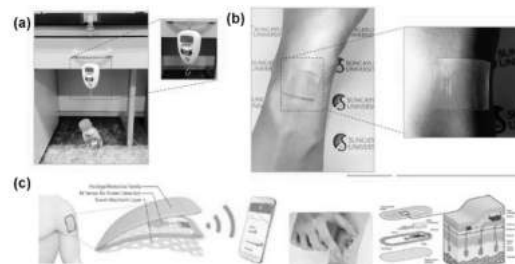


Fig. 4. (a) A load test of crack-embedded patches on set and rough surfaces (0.5N) (b) Intersection for skin patch sensor system and human skin. (c) Integrated devices utilized in smart dry adhesive, medical diagnosis systems