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Bionic Anisotropic Hydrophobic-Coating Hydrogels

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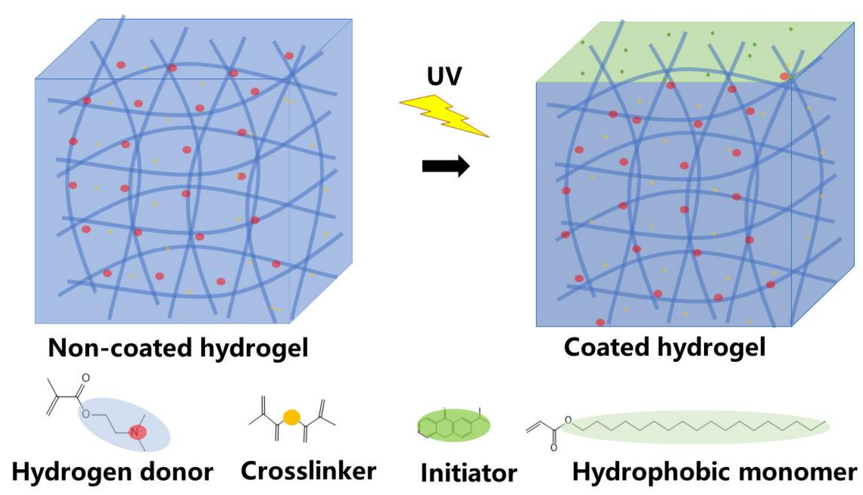
ABSTRACT:

The anisotropic structures of human skin, cartilage and muscle are the basis of their complex functions. These structures originate from the anisotropic distribution of biomolecules and other signal molecules. At the same time, the control of anisotropic mass diffusion is considered to be the key to the construction of artificial organs and multi-organs coculture in organ-on-a-chip. Although there are complex micro-channels designed to control the mass transport, they are still different from real natural organs. Inspired by the multilayer structure of skin and blood vessels, we developed a novel strategy to solve the problem in this work. A hydrophobic layer was formed on the hydrogel surface to control substance diffusion. This method can be conveniently modified on the surface of various functional hydrogels to achieve directional diffusion of substances such as culture media and biological factors, and can also be combined with optical mask plate or additive manufacturing to modify more complex surfaces and structures.

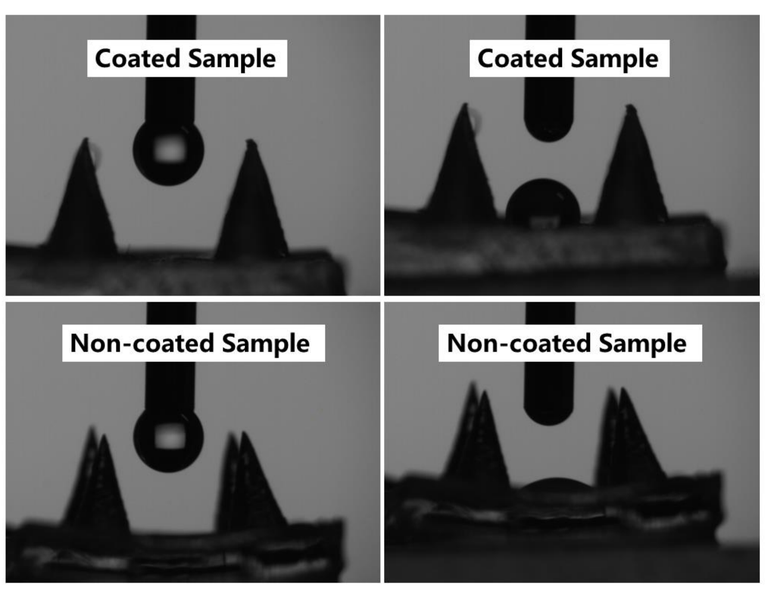
PRINCIPLE:

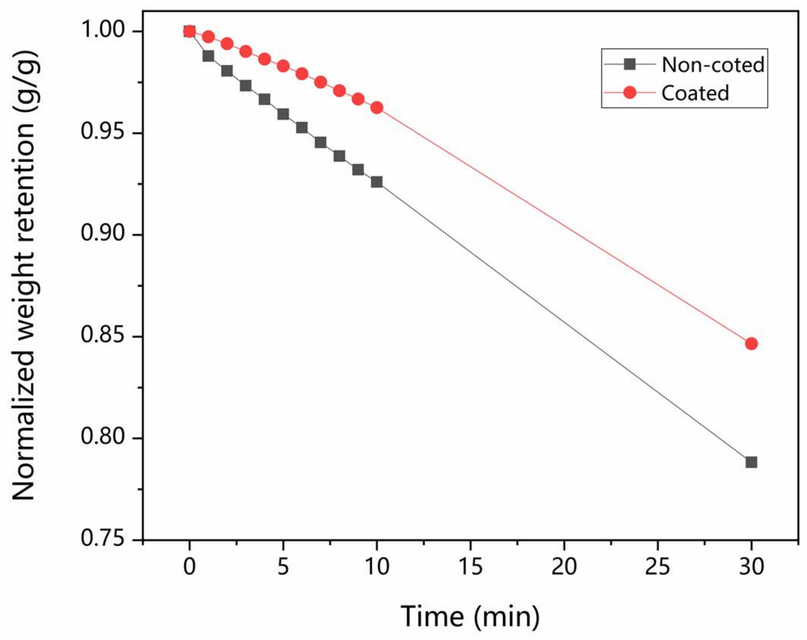
Inspired by stratum corneum in human skin, photopolymerization is used to graft hydrophobic polymers on the hydrophilic hydrogel surface by the hydrogen donor in the substrate.



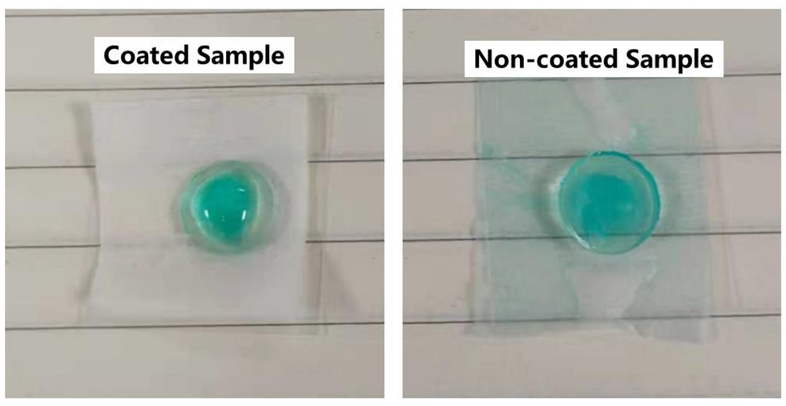
RESULTS:

Microneedles hydrogel have been made with PEG-SBMA-DMAEMA copolymer. After coated with hydrophobic polymer, the water contact angle changes from ~30° to ~90°。





Water molecules are distributed in the hydrogel network. However, water will be inevitably evaporating at the interface with air. The covalent binding hydrophobic polymer wrap the hydrogel surface, act like stratum corneum in skin. It takes ~twice time in coated sample than non-coated sample to evaporate the water of same weight.



After surface modification, the substance release can be site controlled. A drop of $CuSO_4$ solution was added onto the surface of hydrogel. Non-coated sample will be infiltrated rapidly, and the dry paper was dyed to be blue. Whereas, the paper under the coated sample keep clean.

CONCLUSION and PLAN:

This study shows a simple and one-step protocol to modify hydrophilic hydrogel substrate, and presents a proof of concept data of soluble mass controllable diffusion in the hydrogel. The anisotropic hydrophobic-coating hydrogels demonstrate potential of directional diffusion of substances in organ-on-a-chip. Our next step is to use the hydrogel to deliver different biological factors in 3D cell culture to construct anisotropic tissue.