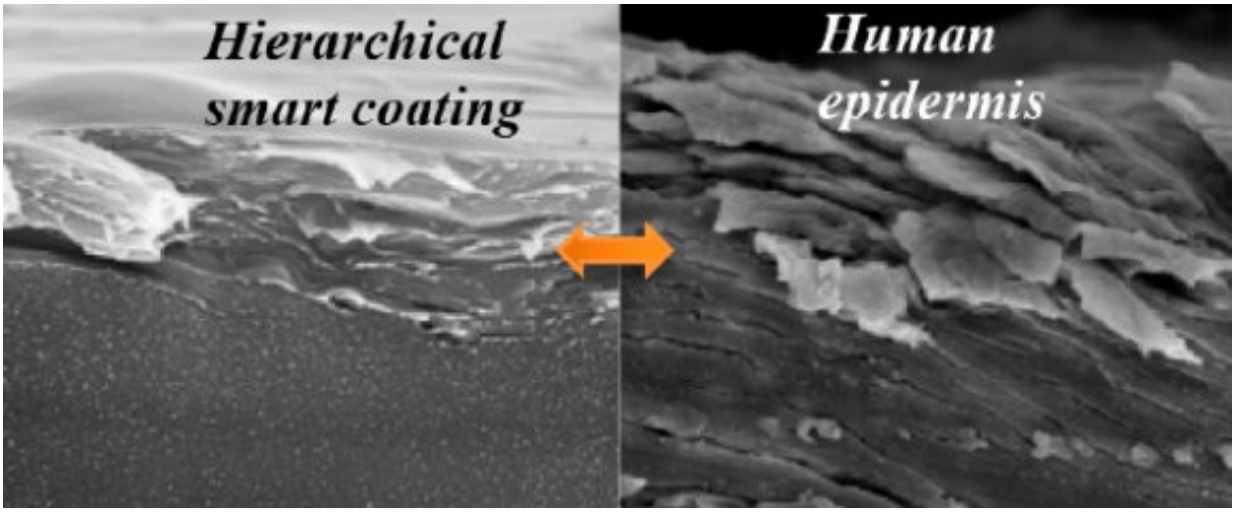
Skin-inspired coating that's as hard as teeth and can heal itself

January 31 2018



Credit: American Chemical Society

Self-healing smart coatings could someday make scratches on cell phones a thing of the past. But researchers often have to compromise between strength and the ability to self-repair when developing these materials. Now, one group reports in *ACS Nano* the development of a smart coating that is as hard as tooth enamel on the outside but can heal itself like skin can.

The smart coating market is a booming industry and is only expected to grow in upcoming years. The most common smart coatings that can heal

themselves are based on soft polymers that can wear out quickly. But hard coatings can be too rigid to come back together to fix a tear or scratch. In previous research, Ming Yang and colleagues produced a stiffer, more healable coating, but its performance still needs to be optimized. In the current paper, the researchers developed a different way to make a soft, yet hard, self-healing material.

Mimicking the structure of human skin, the researchers used a layer-by-layer technique to form a soft, dynamic under layer containing polyvinyl alcohol and tannic acid. The hard outer layer contained these compounds plus a layer of graphene oxide. When fabricated at a certain thickness, the material successfully healed itself when cut, and it also could kill bacteria. The material could someday serve as an electronic skin or even as a scratch-proof coating on buildings or phones.

More information: An Epidermis-link Hierarchical Smart Coating with a Hardness of Tooth Enamel, *ACS Nano* (2018). pubs.acs.org/doi/abs/10.1021/acsnano.7b05478

ABSTRACT

We overcome the fundamental dilemma in achieving hard materials with self-healing capability by integrating an epidermis-like hierarchical stratified structure with attractive mechanical and barrier properties of graphene oxide and show that such biomimetic design enables a smart hierarchical coating system with a synergetic healing effect and a record-high stiffness (31.4 ± 1.8 GPa)/hardness (2.27 ± 0.09 GPa) among all self-healable polymeric films even comparable to that of tooth enamel. A quasi-linear layer-by-layer (LBL) film with constituent graphene oxide is deposited on top of an exponential LBL counterpart as a protective hard layer, forming a hierarchical stratified assembly mimicking the structure of epidermis. The hybrid multilayers can achieve a complete restoration after scratching thanks to the mutual benefit: The soft

underneath cushion can provide additional polymers to assist the recovery of the outer hard layer, which in turn can be a sealing barrier promoting the self-healing of the soft layer during stimulated polymer diffusion. The presenting hybridization mode of LBL assembly represents a promising tool for integrating seemingly contradictory properties in artificial materials with potential performances surpassing those in nature.

Provided by American Chemical Society