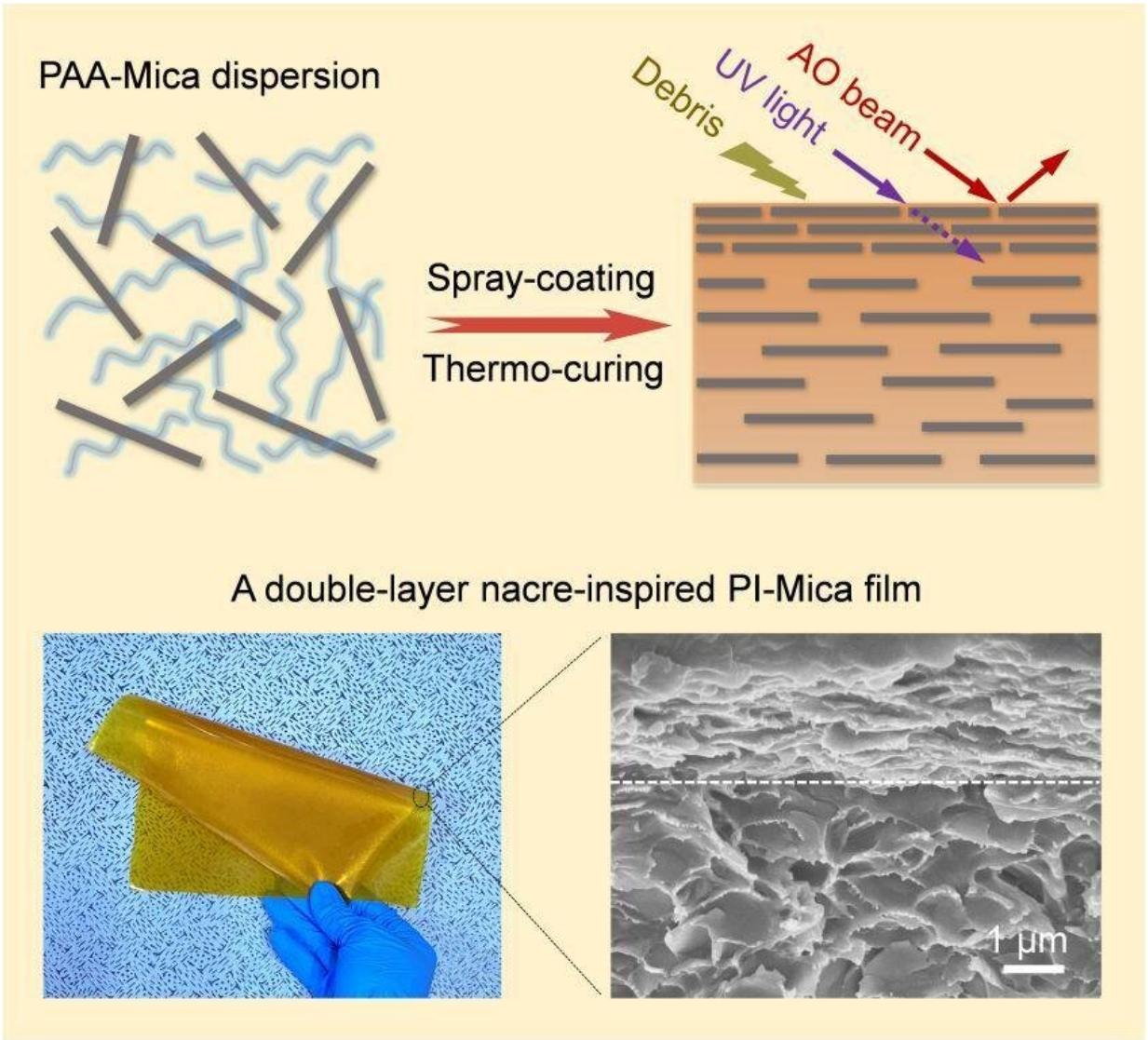
Development of polyimide-mica nanocomposite film with high resistance to low-Earth-orbit environments

December 1 2021, by Liu Jia



Fabrication of the double-layer nacre-inspired film. Credit: Pan Xiaofeng et al.

Polyimide (PI) composite films are widely used on the external surfaces of spacecraft to protect them from the adverse environments of low Earth orbit (LEO) due to their outstanding comprehensive performance. However, current PI composite films have inadequate mechanical properties and atomic oxygen (AO) resistance.

In a study published in *Advanced Materials*, a research team led by Prof. Yu Shuhong from University of Science and Technology of China (USTC) of the Chinese Academy of Sciences proposed a unique double-layer nacre-inspired structural design strategy, and fabricated a new PI-based nanocomposite film with greatly enhanced mechanical properties and AO resistance.

Inspired by the brick-and-mortar microstructure of natural nacre, researchers assembled mica nanosheets and PI into a double-layer nacre-inspired structure with a much higher density of mica in the top layer, which was achieved via a straightforward spray assisted assembly followed by a thermo-curing process.

By optimizing the component proportions and top layer thickness, the mechanical properties of the double-layer PI-Mica film were significantly enhanced. The tensile strength, Young's modulus, and surface hardness of the double-layer film were 45 percent, 100 percent, and 68 percent higher than those of pure PI films, respectively.

By virtue of the unique double-layer nacre-inspired structure and the intrinsic advantages of mica nanosheets, the obtained double-layer PI-Mica film achieved much better AO resistance, UV aging resistance (313 nm), and high-temperature stability (380 °C) than pure PI film. In

addition, both AO fluence and erosion yield characteristics of the double-layer PI-Mica film are superior to previously reported PI-based composites. Thus, this double-layer PI-Mica film may serve as a new type of aerospace protective material, replacing existing PI-based composite films for LEO applications.

The unique double-layer nacre-inspired structural design provides a promising avenue for future design and fabrication of other high-performance bioinspired nanocomposites for diverse applications.

More information: Xiao-Feng Pan et al, Double-Layer Nacre-Inspired Polyimide-Mica Nanocomposite Films with Excellent Mechanical Stability for LEO Environmental Conditions, *Advanced Materials* (2021). DOI: 10.1002/adma.202105299

Provided by Chinese Academy of Sciences