Nano Science, Technology and Industry Scoreboard

Researchers Find Relationship Between Silver Nanowire Film Plasticity and Shear Fracture Resistance

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A research team led by JI Shulin from the Hefei Institutes of Physical Science of the Chinese Academy of Sciences (CAS) has recently discovered that the better the plasticity of the silver nanowire films, the more resistant they were to shear fracture after they studied the mechanism of silver nanowire films. Results were published in Nanotechnology.

Silver nanowire transparent conductive films show outstanding application advantages for touch screens, sensors, solar cells, film heaters and other fields due to their excellent conductivity, optical high definition and good flexibility. However, as one of the important flexible electronic materials under extreme mechanical conditions, the properties of silver nanowire films are unstable.

The study of the fracture behavior of silver nanowires in thin films under shear stress involved shear tests, nano-indentation experiments, stress-strain theoretical simulation and in-depth microstructural analysis. The researchers found that using different diameters of nanowires and film thicknesses to transfer forces in the films, plastic deformation caused by defect nucleation and movement in the stress concentration area would lead to differences in nanowire "necking".

Therefore, adding an ultra-thin metal buffer layer between the silver nanowire film and the substrate to disperse the stress could improve the shear fracture resistance of the films without affecting the optical properties, and could also enhance the flexural stability of the films.

In addition to shear fracture, the team investigated film uniformity and anti-scratch resistance under repeated bending. They achieved higher uniformity than Indium Tin Oxide with a surface hardness of 3H over thousands of bends.

Figure 1. Bending resistance and surface scratch resistance of silver nanowire films for folding screens.

Figure 2. Load-displacement curves of silver nanowire films with different nanowire diameters and film thicknesses.

Figure 3. Stress-strain curves of silver nanowire films with different nanowire diameters and film thicknesses.

Figure 4. Microstructural characterization of different parts of a silver nanowire after fracture under film shear stress.

This work provides a new idea for large-scale industrial application of silver nanowire thin films. And it was funded by the Youth Innovation Promotion Association of CAS, the National Natural Science Foundation of China, the Anhui Natural Science Foundation, among others.