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Relationship between silver nanowire film plasticity and shear fracture resistance

June 20 2022, by Zhang Nannan

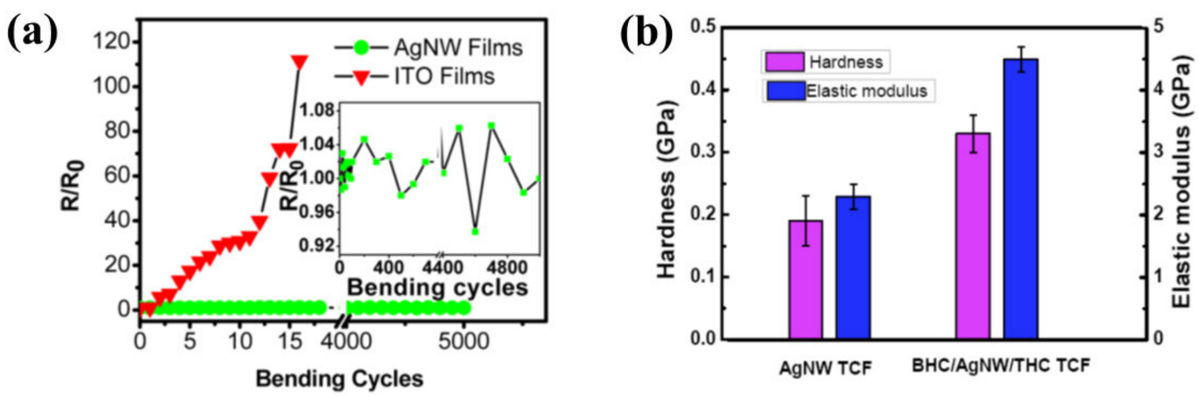

Figure 1. Bending resistance and surface scratch resistance of silver nanowire films for folding screens. Credit: Wang Mengjiao

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

Silver nanowire transparent conductive films show outstanding application advantages for touch screens, sensors, solar cells, and film heaters 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 by 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.

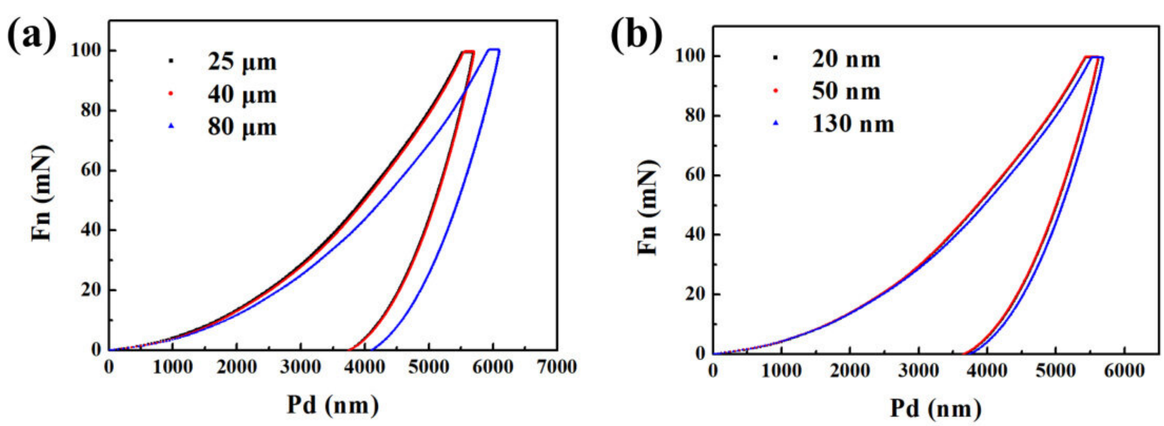

Figure 2. Load-displacement curves of silver nanowire films with different nanowire diameters and film thicknesses. Credit: Wang Mengjiao

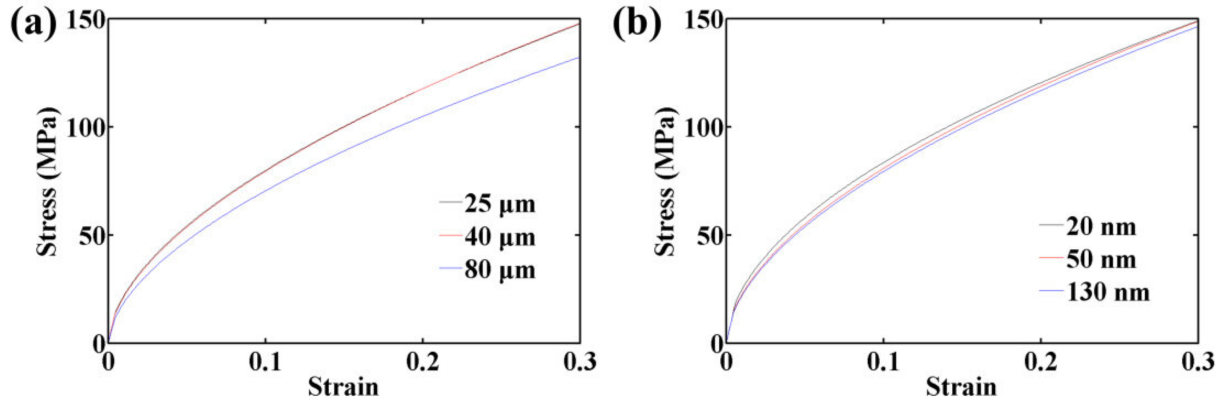

Figure 3. Stress-strain curves of silver nanowire films with different nanowire diameters and film thicknesses. Credit: Wang Mengjiao

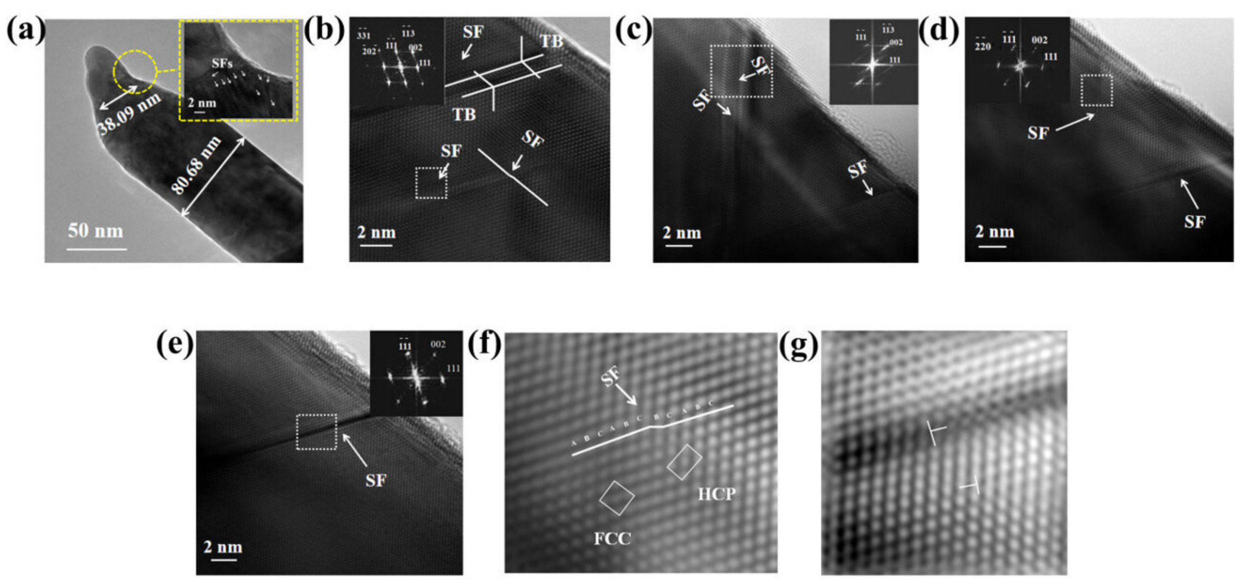

Figure 4. Microstructural characterization of different parts of a silver nanowire after fracture under film shear stress. Credit: Wang Mengjiao

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.

More information: Mengjiao Wang et al, Fracture behaviour of silver nanowire films during shear deformation, *Nanotechnology* (2022). DOI: 10.1088/1361-6528/ac7731

Yonggao Jia et al, Silver Nanowire Transparent Conductive Films with High Uniformity Fabricated via a Dynamic Heating Method, *ACS Applied Materials & Interfaces* (2016). DOI: 10.1021/acsami.6b00500

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