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Multifunctional Thermally Conductive Composite Films Based on Heterostructured Silver Nanowires@Boron Nitride Nanosheets and Aramid Nanofibers

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Background

Chip cooling

Mobile communication

Aerospace

Data storage

Artificial intelligence

Flexible electronics

Experimental

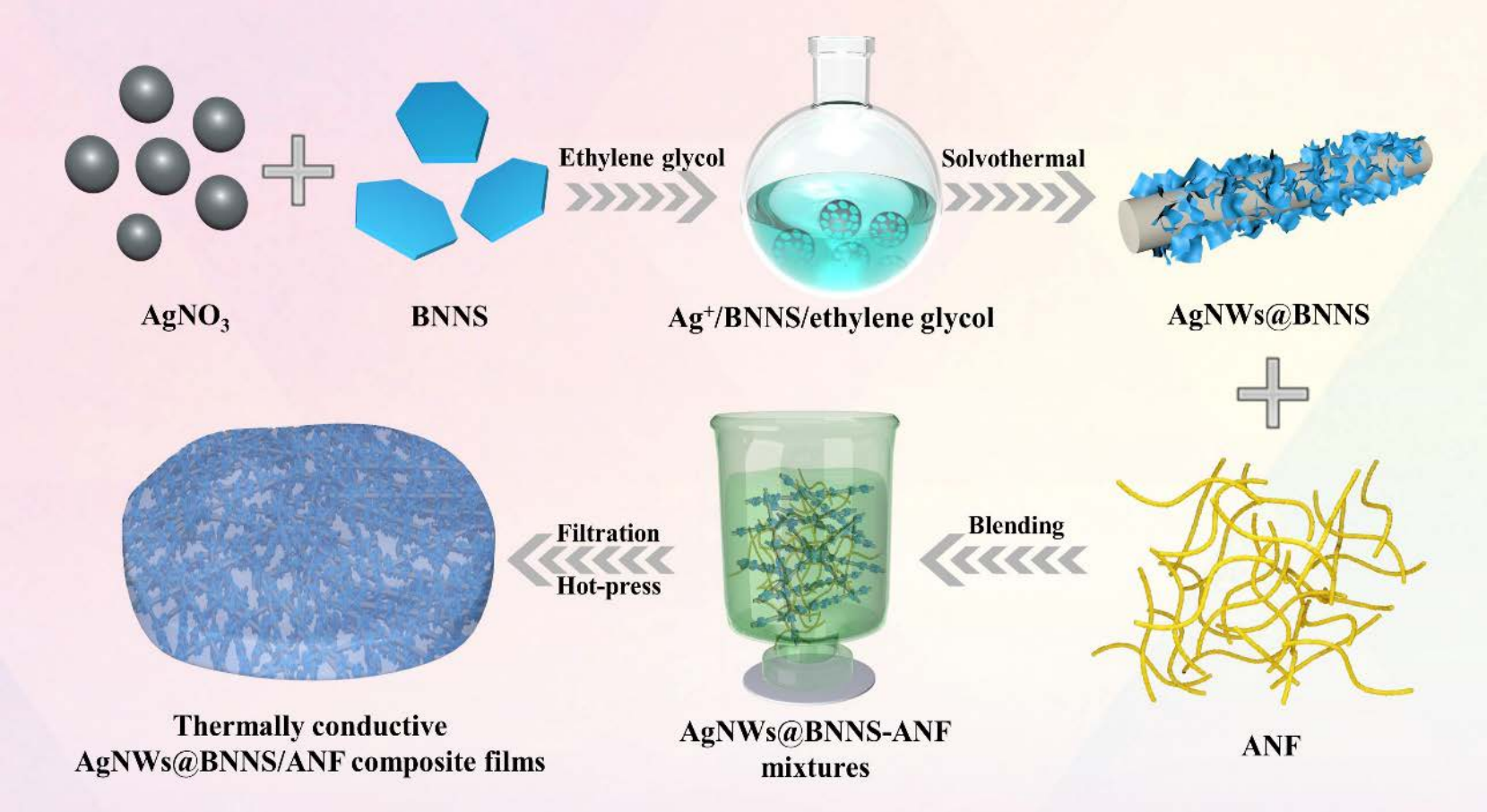

Figure 1 Schematic diagram for the fabrication of thermally conductive AgNWs@BNNS/ANF composite films.

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Results and Discussions

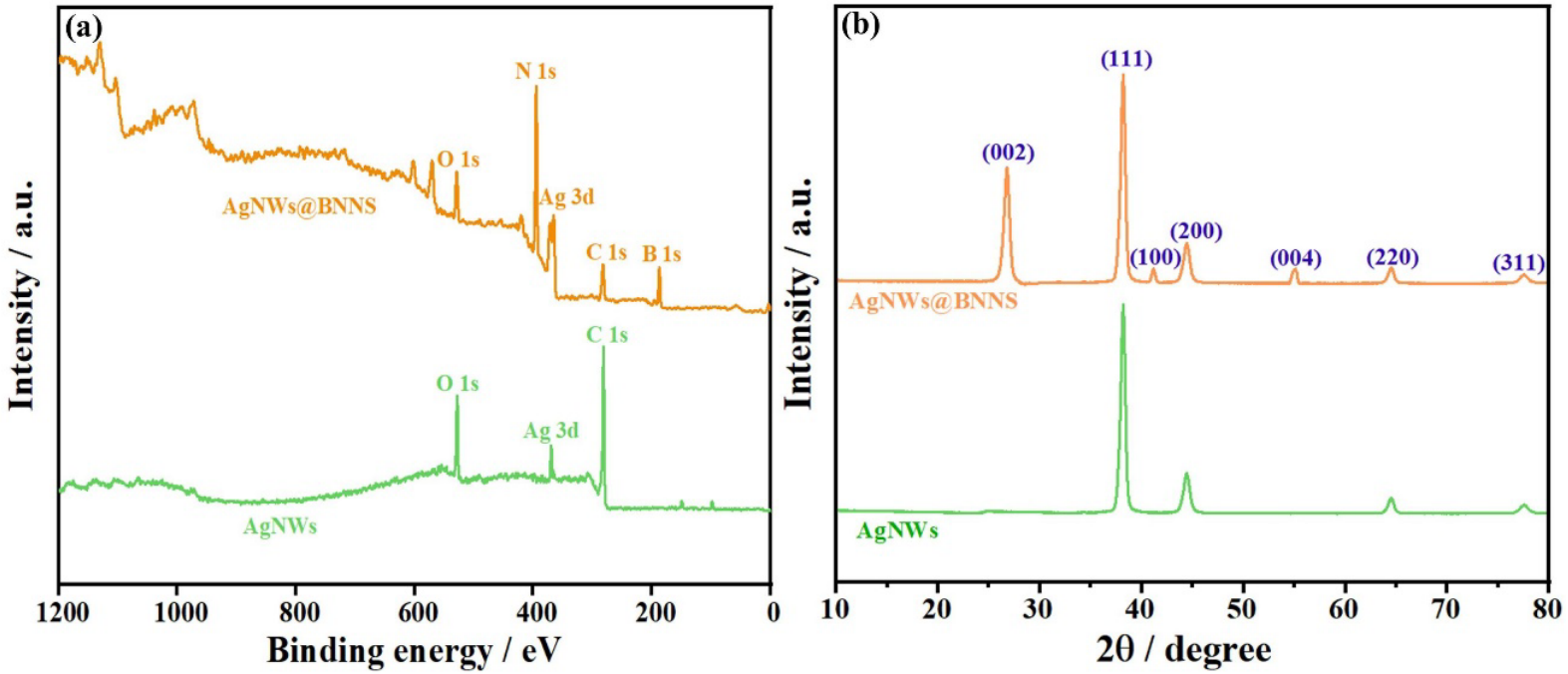

Figure 2 XPS spectra (a) and XRD patterns (b) of AgNWs and AgNWs@BNNS fillers.

Results and Discussions

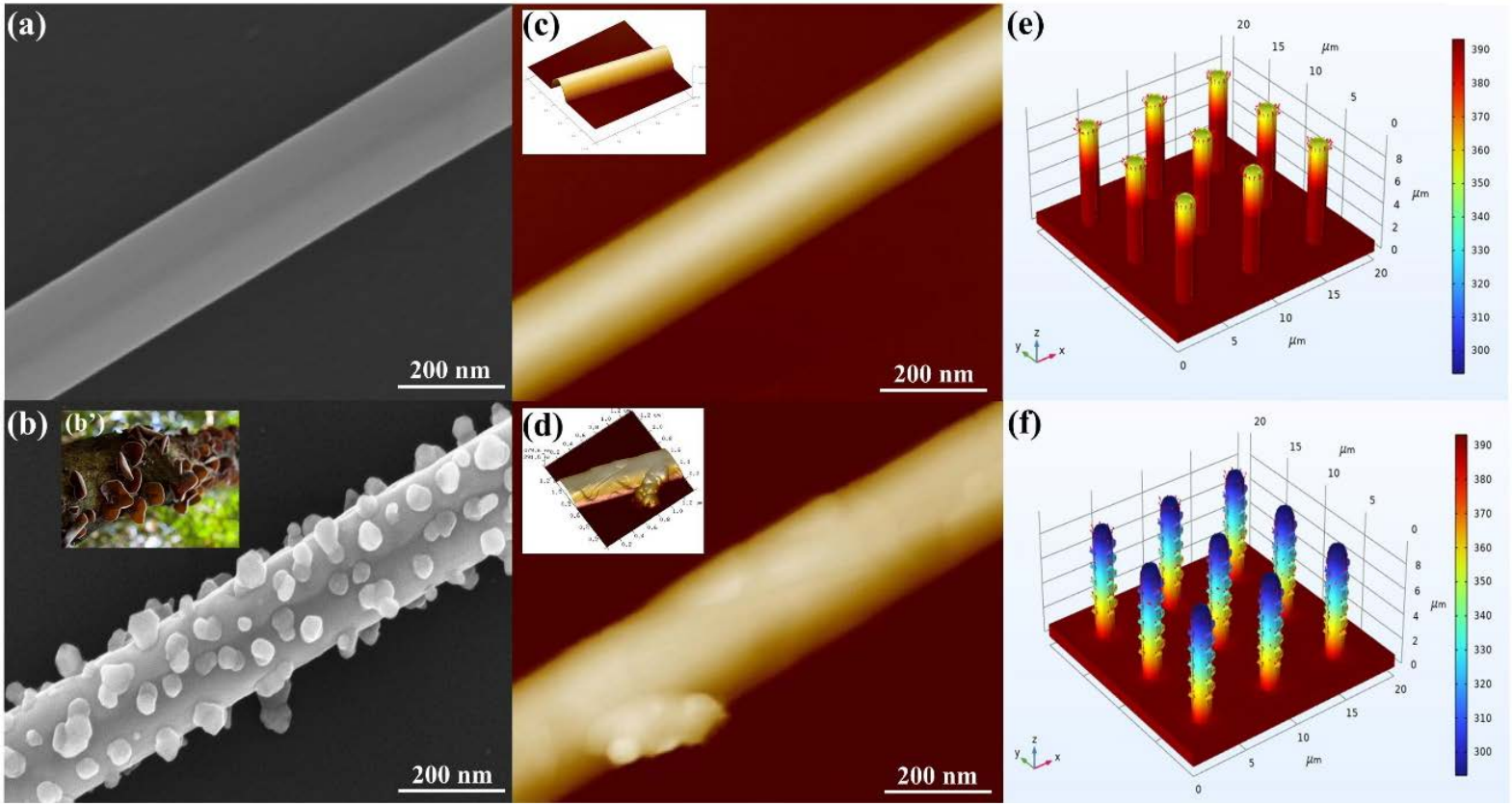

Figure 3 SEM images (a-b), AFM images (c-d), and overall temperature distribution via finite element analyses (e-f) of AgNWs and AgNWs@BNNS fillers.

Results and Discussions

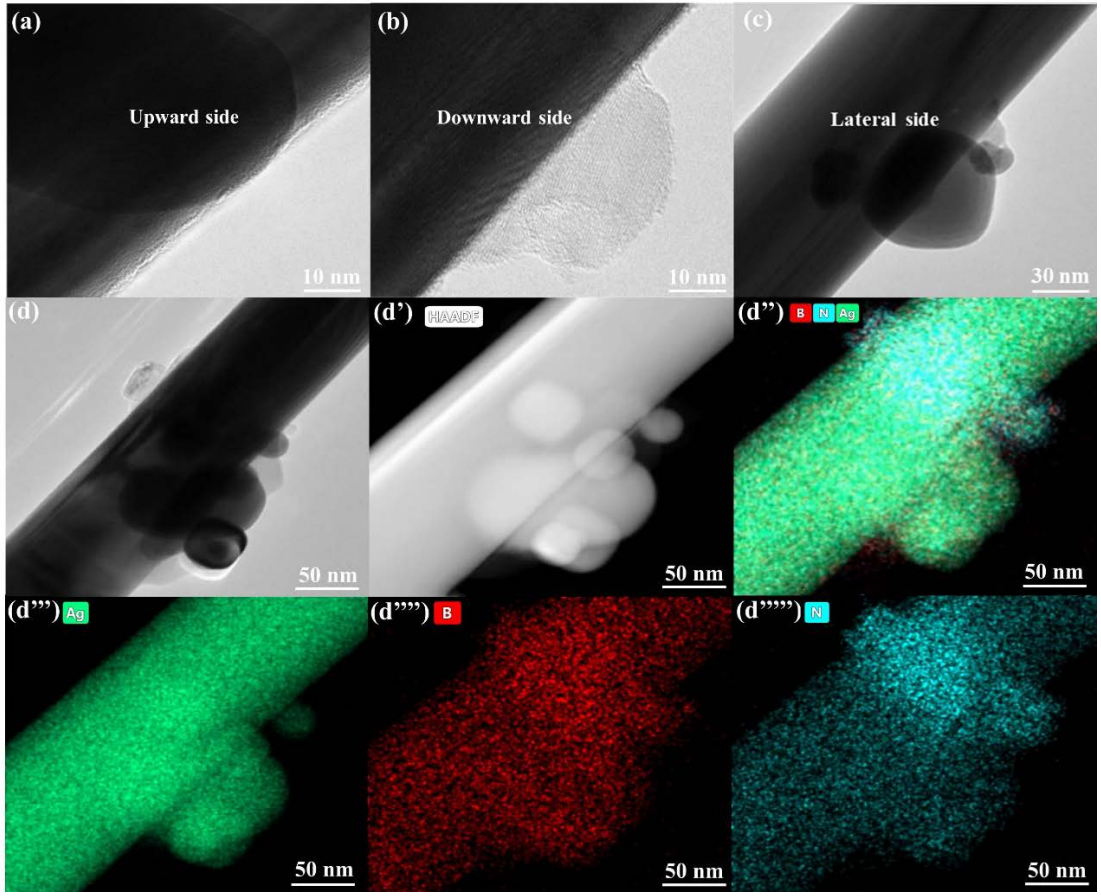

Figure 4 TEM (a-d), high-angle annular dark field (HAADF) (d') and EDS (d"-d""") images of AgNWs@BNNS fillers.

Results and Discussions

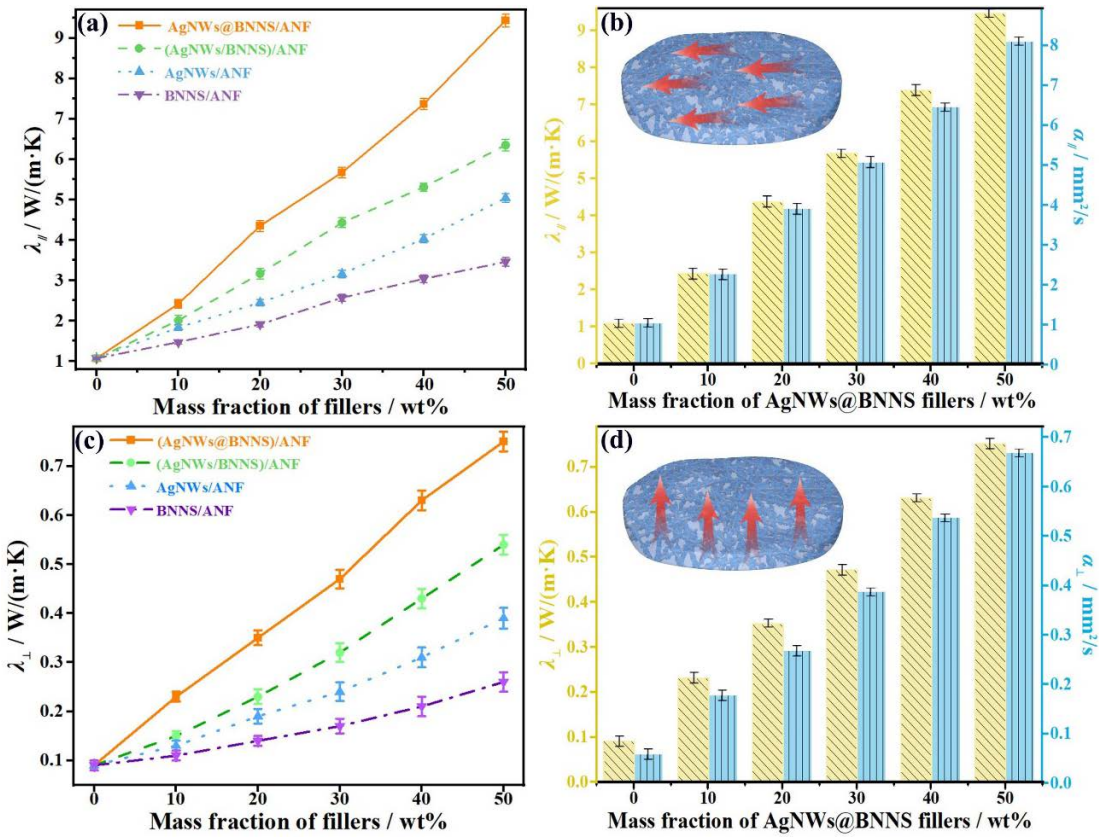

Figure 5 $\lambda_{//}$ (a) and $\lambda_{\perp}$ (c) of the thermally conductive ANF composite films; $\lambda_{//}$ & $\alpha_{//}$ (b) and $\lambda_{\perp}$ & $\alpha_{\perp}$(d) of the thermally conductive AgNWs@BNNS/ANF composite films.

Results and Discussions

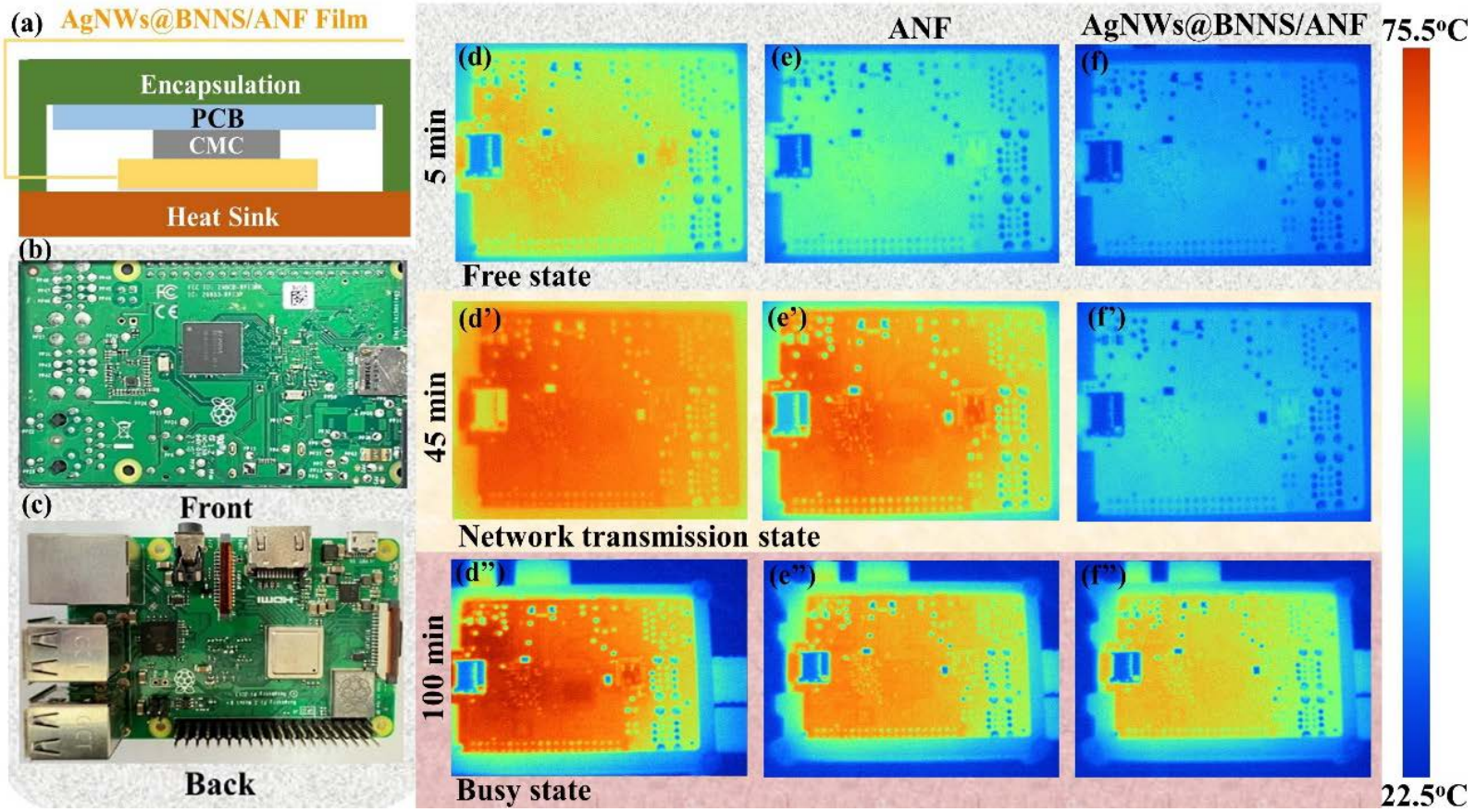

Figure 6 Application of thermally conductive 50 wt% AgNWs@BNNS/ANF composite film in micro-card computer (a-c), in free state (d-d"), network transmission state (e-e"), busy state (f-f").

Results and Discussions

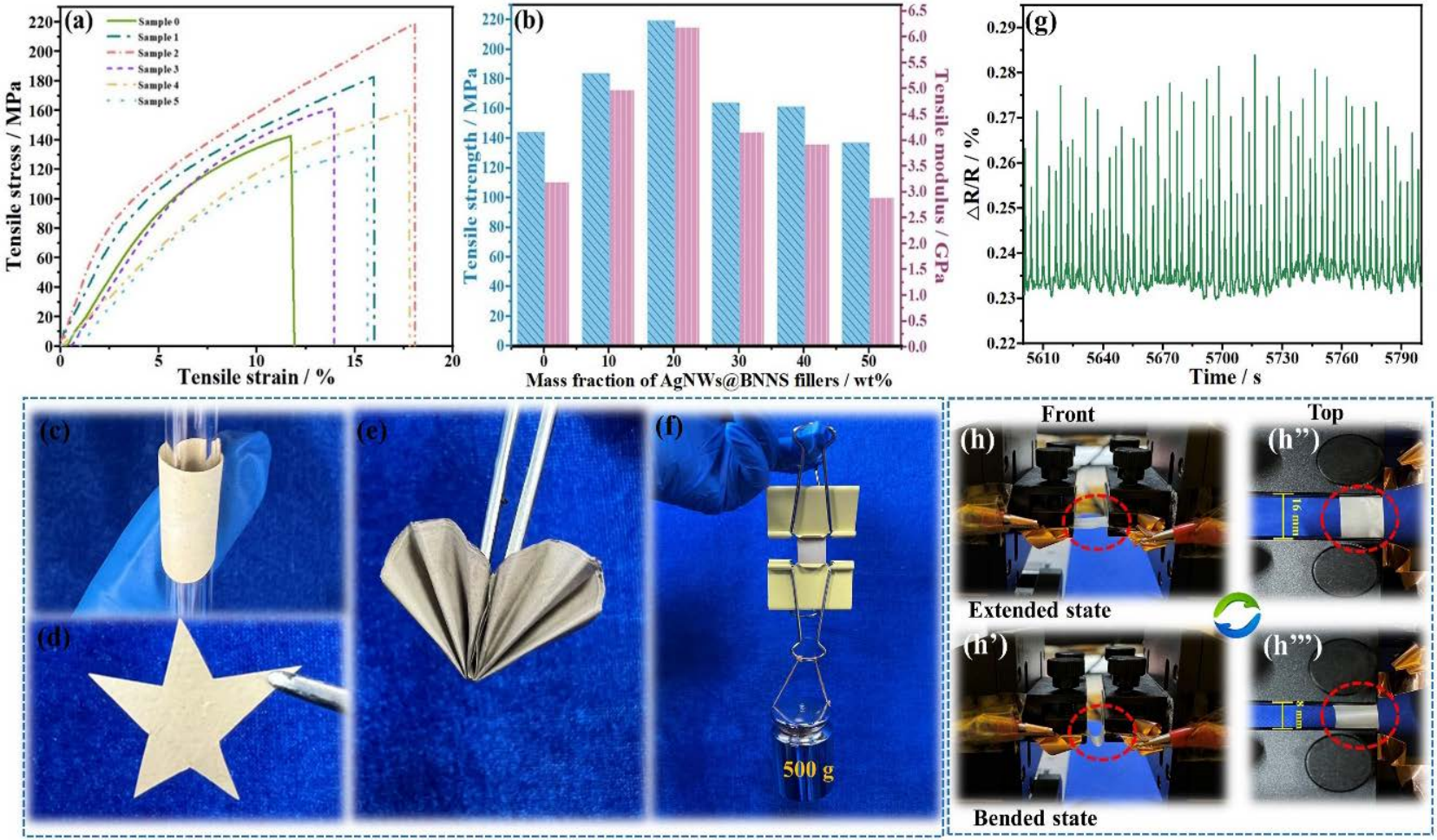

Figure 7 Tensile stress-strain curves (a), tensile strength & modulus (b) of the thermally conductive AgNWs@BNNS/ANF composite films; optical photographs of 50 wt% AgNWs@BNNS/ANF composite films possessing ultra-flexibility (c),tailorability (d), foldability (e) and withstanding a weight of 500 g (f). Real-time resistance change rate monitoring value under strain (h), front view (h-h") and top view (h'-h"') photographs of 50 wt% AgNWs@BNNS/ANF composite film in fatigue cycle.

Summary

- **"Fungal tree"-like hetero-structured silver nanowires@boron nitride nanosheet (AgNWs@BNNS) thermally conductive fillers are prepared by the method of "solvothermal & in-situ growth".**

- **Thermally conductive AgNWs@BNNS/ANF composite films have the optimal thermal conductivity coefficient of 9.44 W/(m·K) and excellent tensile strength of 136.6 MPa.**

- **Thermally conductive AgNWs@BNNS/ANF composite films have good temperature-voltage response characteristics (e.g., high Joule heating temperature at low supply voltage (5 V, 240.6^{o}C), fast response time (10 s)).**

- **Thermally conductive AgNWs@BNNS/ANF composite films have excellent electrical stability and reliability, exhibiting stable and constant real-time relative resistance under up to 1000 times, 6000 s of tensile-bending fatigue work test.**

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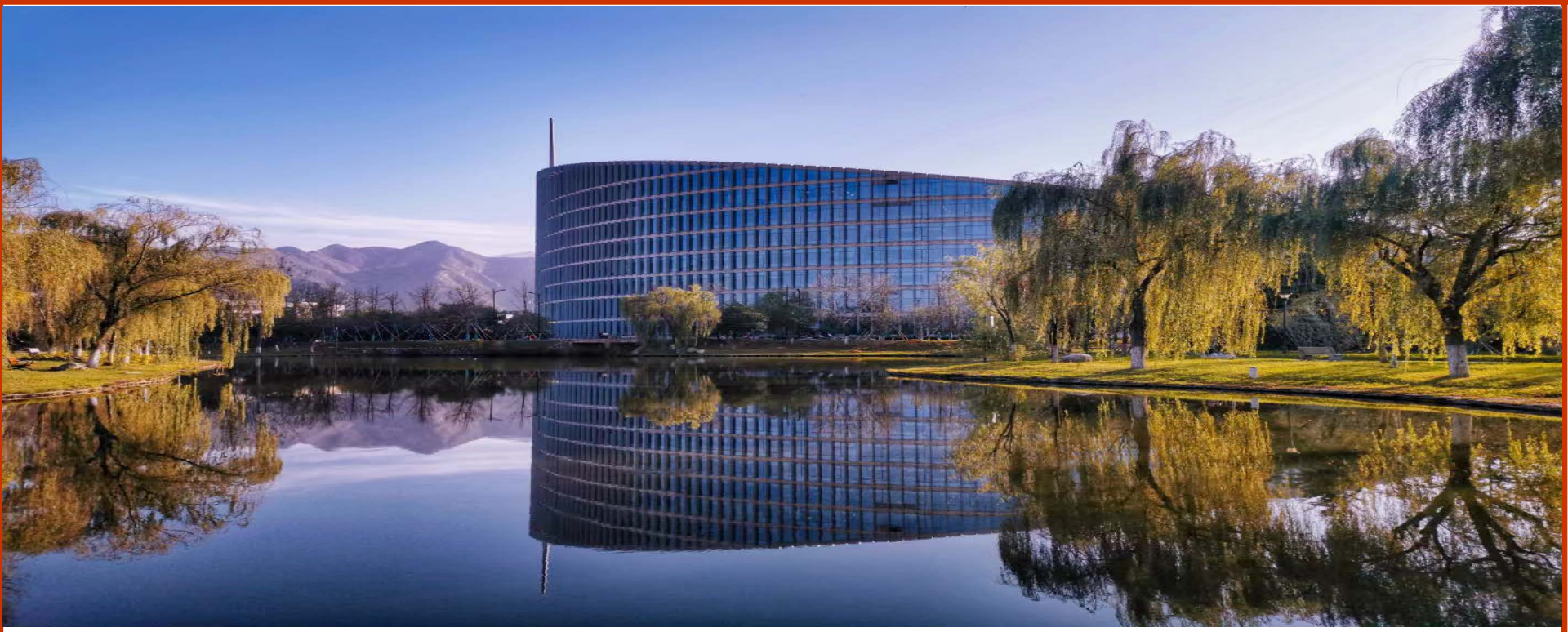

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