Supporting Information

High-Performance, Biaxially Stretchable Conductor Based on Ag Composites and Hierarchical Auxetic Structure

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Experimental Section

Preparation of Hierarchically Structured PDMS Mold

For the hierarchical structures, the fractal cut patterns were printed using a strerolithographic 3D printer (Form 2, Form-labs). This pattern was transferred to the PDMS mold by replica molding. To easily release the Ag conductor, the PDMS mold was surface-treated by vapor-phase deposi-tion using (tridecafluoro-1,1,2,2-tetrahydrooctyl)trichlorosilane (SIT8174.0, Gelest) in a vacuum desiccator after oxygen plasma treatment.

Fabrication of Biaxially Stretchable Conductor

To prepare Ag pastes, Ag flakes (DSF-500MWZ-S, Daejoo Electronic Materials Co.) were mixed with MIBK (Sigma-Aldrich) and PDMS (Sylgard 184, Dow Corning Corp.) in 3–9:2:1 weight ratio, followed by vortexing and sonication. Then, the Ag pastes with different volume fractions (22–45 vol%) were dropped onto the surface-treated PDMS mold, followed by blading it across the PDMS mold. After solvent evaporation and curing, a PDMS supporting layer was formed on the Ag pastes by the same process. The bi-layered conductor comprising Ag pastes and the PDMS supporting layer was released from the mold after curing for 3 h in an oven at 80 °C.

Characterization of stretchable conductos

The electrical resistance and stretcha-bility of the stretchable conductors were measured using a digital multimeter (DMM7510, Keithley) and biaxial stretching machine (Namil Optical Instruments), respective-ly. The Young's modulus of the Ag conductor was meas-ured using a motorized test stand (ESM 303, Mark-10, USA) and a force gauge (M7-2, Mark-10, USA). The I-V curves were measured using a source meter (2450 SourceMeter, Keithley) under various strains (0–50%) in the external voltage range of 0 to +5 V.

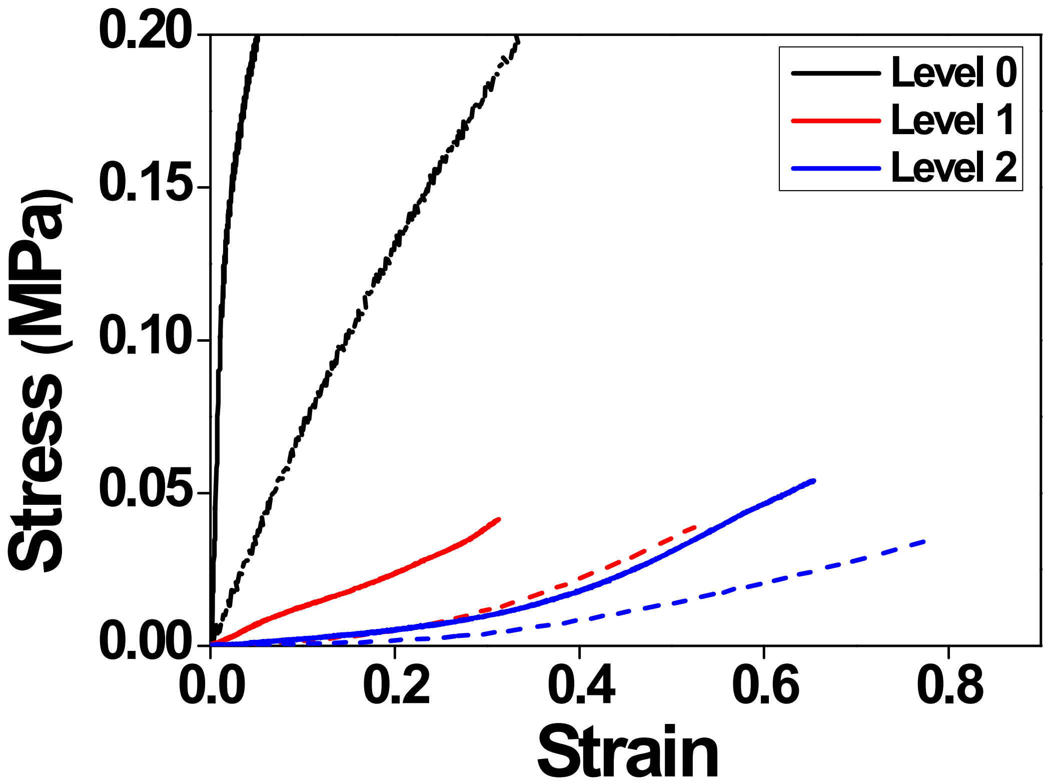

Fig. S1 Stress-strain curves of the hierarchically cut-based conductor at different levels (solid lines: Ag conductors, dash lines: non-conductive films)

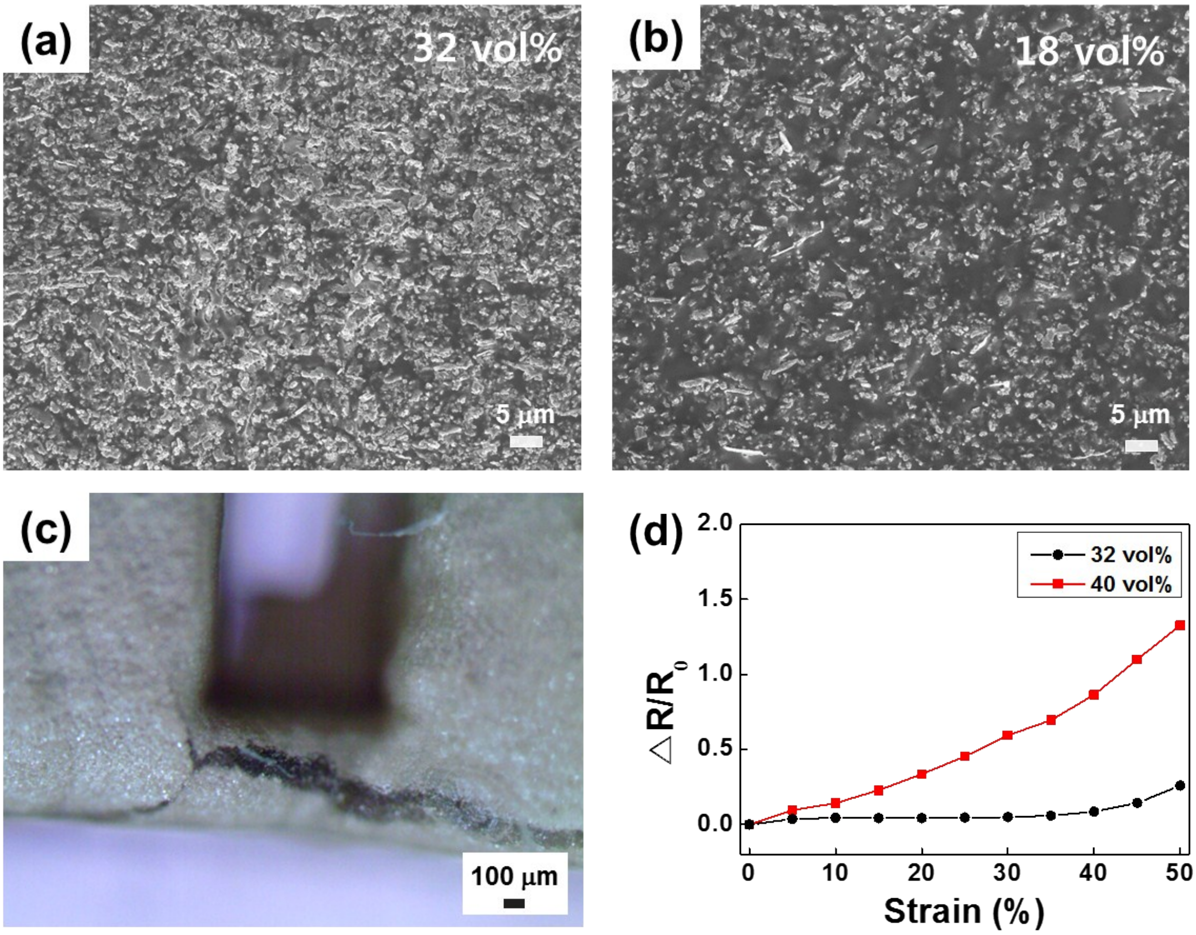

Fig. S2 The cross-sectional SEM image of stretchable conductors with (a) 32 vol% and (b) 18 vol%. (c) Optical microscopy (OM) image of conductor with high volume fraction of Ag flakes. (d) The normalized resistance variation ($\Delta R/R_0$) of stretchable conductor composed of 32, 40 vol% Ag as a function of tensile strain.

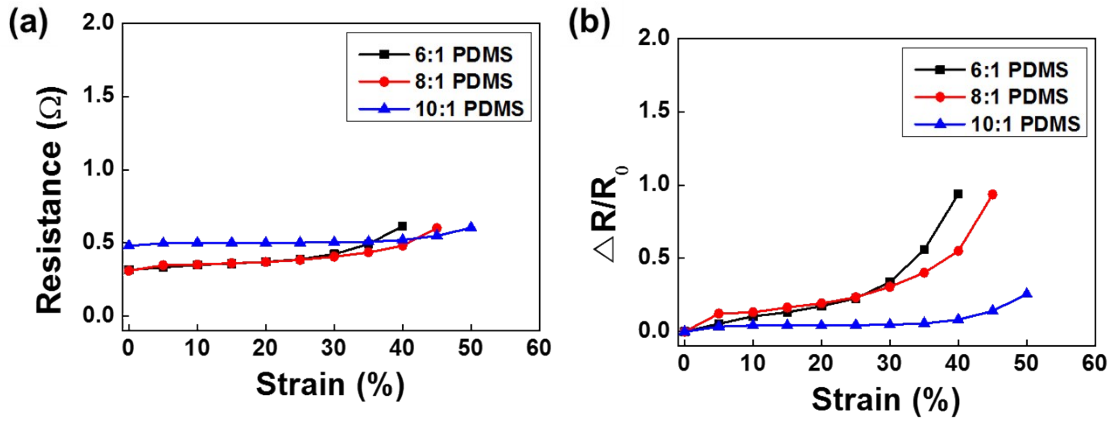

Fig. S3 (a) The resistance variation and (b) the normalized resistance variation of stretchable conductor as a function of Young's modulus.

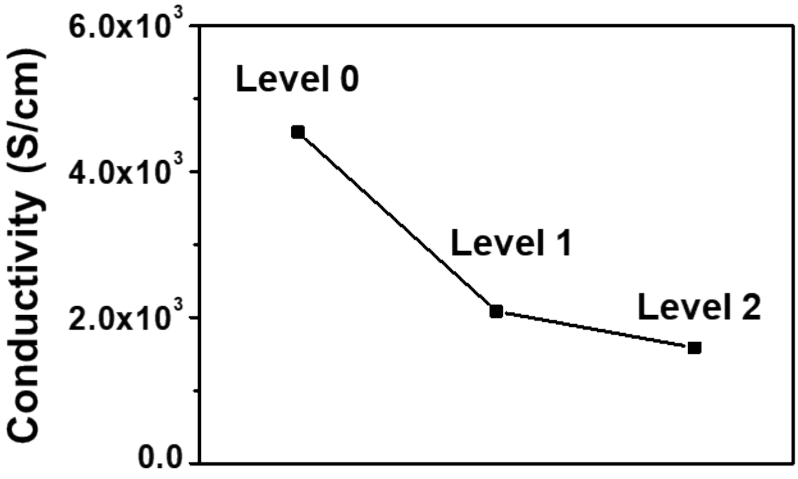

Fig. S4 The conductivity evolution of Ag composites as a function of hierarchy level.

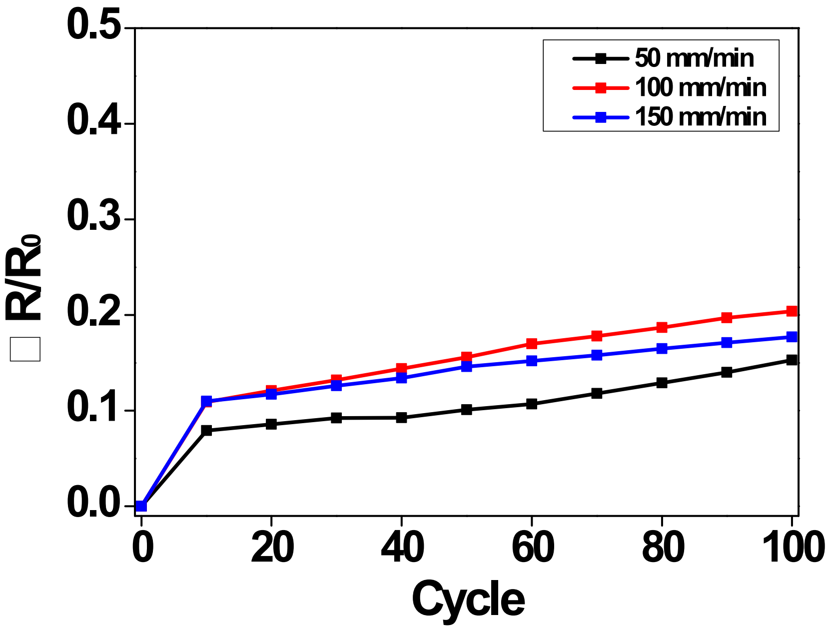

Fig. S5 The normalized resistance change during a long-term cycling test at various stretching speeds.