Supplementary Information

A facile and scalable patterning approach for ultrastretchable liquid metal features

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Supplementary Figures

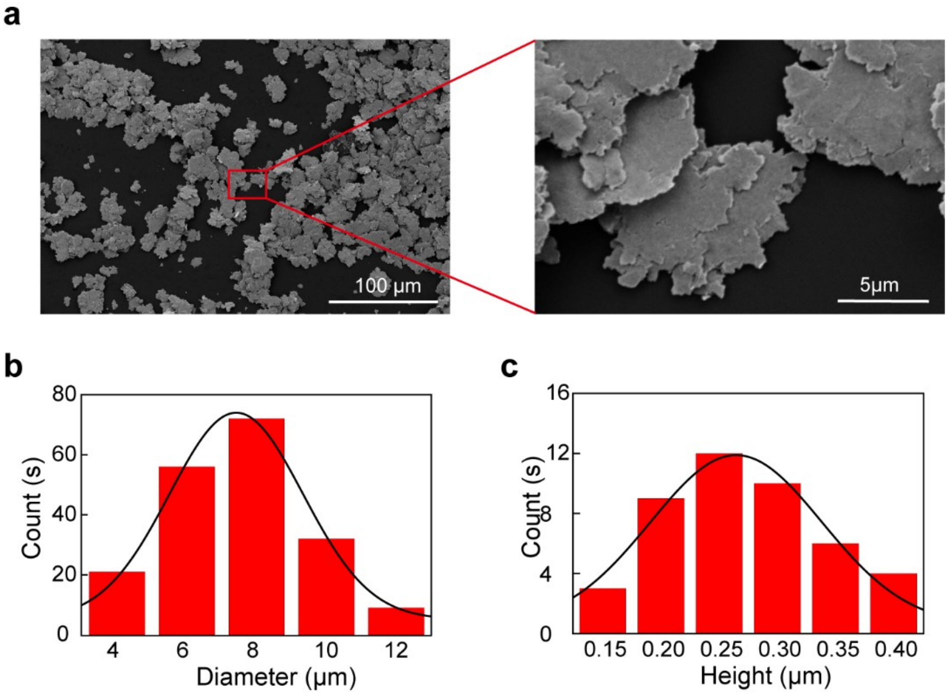

Fig. S1 Structural characterizations on original Ag nanoflakes. a) SEM images of Ag nanoflakes. b) Histogram of diameter distribution according to SEM images. c) Histogram of thickness distribution based on optical surface topographic images. Gaussian fits to the distributions (smooth curves) yield the diameter of 7.4 ± 0.8 µm and the thickness of 0.26 ± 0.05 µm.

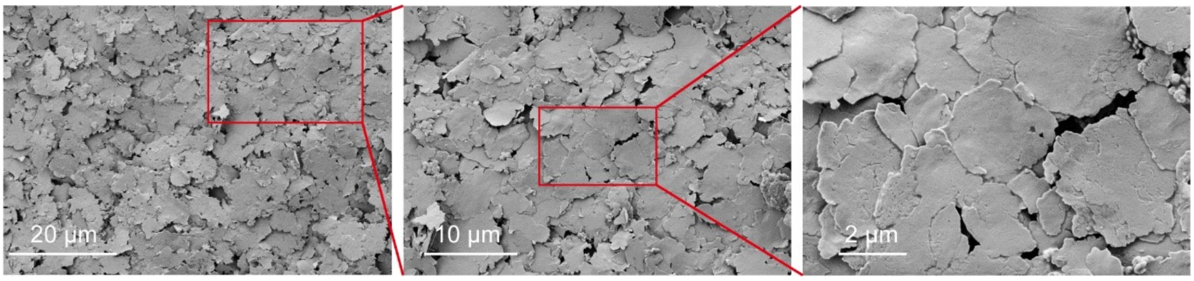

Fig. S2 SEM images of as-printed composite comprising homogenously distributed Ag nanoflakes joint together by SIS elastomer.

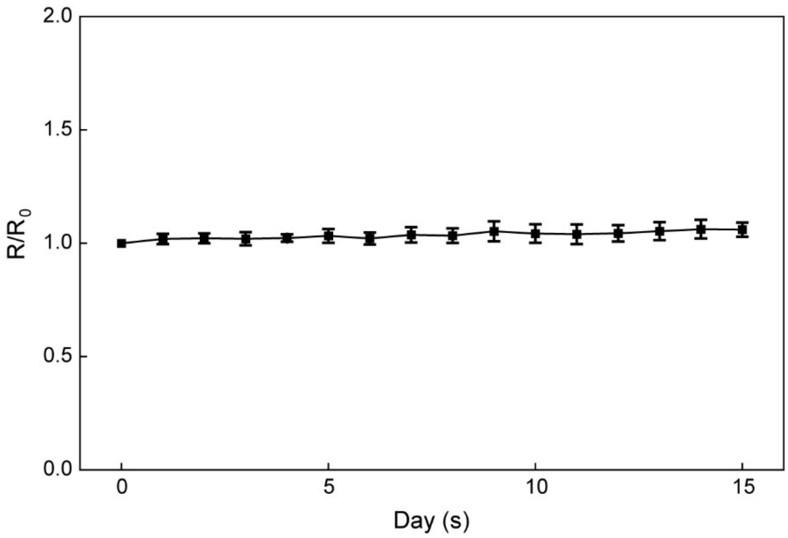

Fig. S3 Long-term environmental stability of the as-prepared liquid metal feature during 15 day-storage under the ambient conditions.

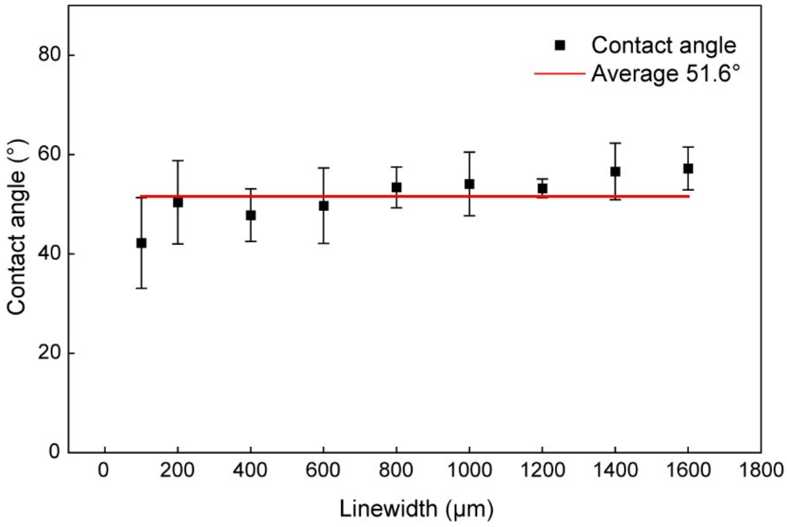

Fig. S4 Contact angles of liquid metal bars with different linewidths on SEBS substrates. The contact angle is almost a constant value of ~ 51.6° due to the stable surface tension established by the large wettability contrast between SEBS elastomer and Ag nanoflake composite.

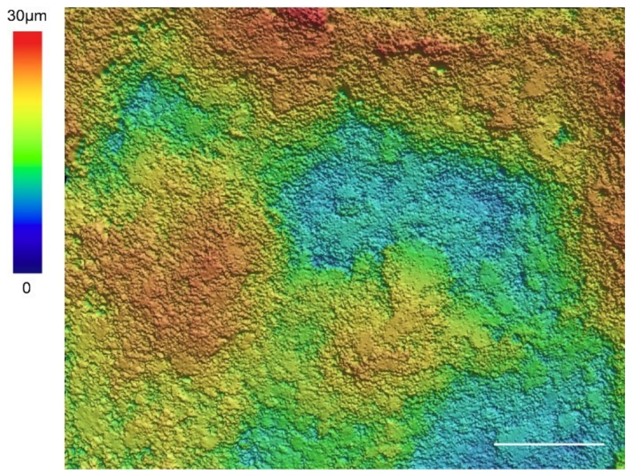

Fig. S5 Surface topographic image of screen-printed Ag nanoflake composite with an average roughness of 2.5 μm. Scale bar: 50 μm.

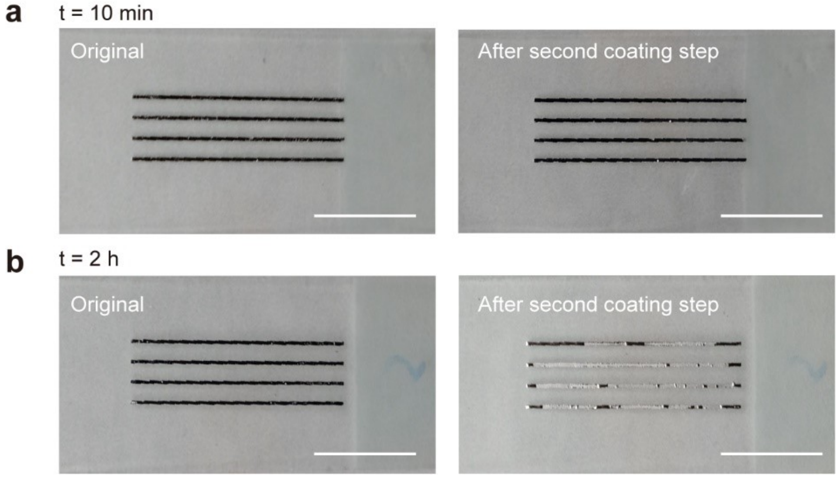

Fig. S6 Gradual dissolution behavior of Ag nanoflake composite underneath the liquid metal feature. Screen-printed Ag nanoflake composite on SEBS substrate is selectively coated with liquid metal. After a certain amount of time t, a second coating step is carried out inside dilute NaOH solution by rolling bulk liquid metal over the entire substrate. a) Optical images showing the outcome of the second coating step performed at t = 10 min after the sample preparation. The excellent retention of the feature morphology suggests the presence of a fairly intact Ag composite film as the adhesion layer between liquid metal and the substrate. b) Images showing the case for the second coating step performed at t = 2 h after the sample preparation. The substantial detachment of the liquid metal feature suggests the loss of the adhesion layer due to gradual dissolution of Ag nanoflakes through the alloying reactions. Scale bars: 2 cm.

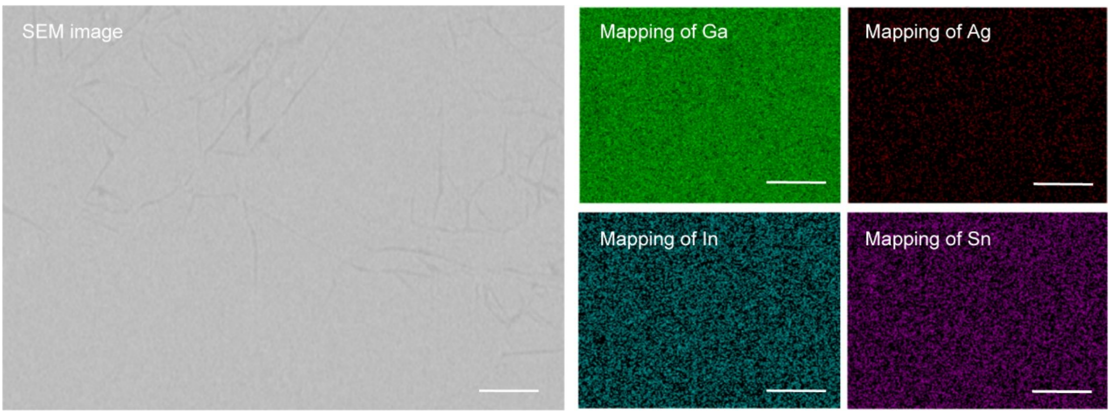

Fig. S7 SEM image (left) and corresponding EDS elemental maps (right) of as-prepared liquid metal features. Scale bars: 5 μm.

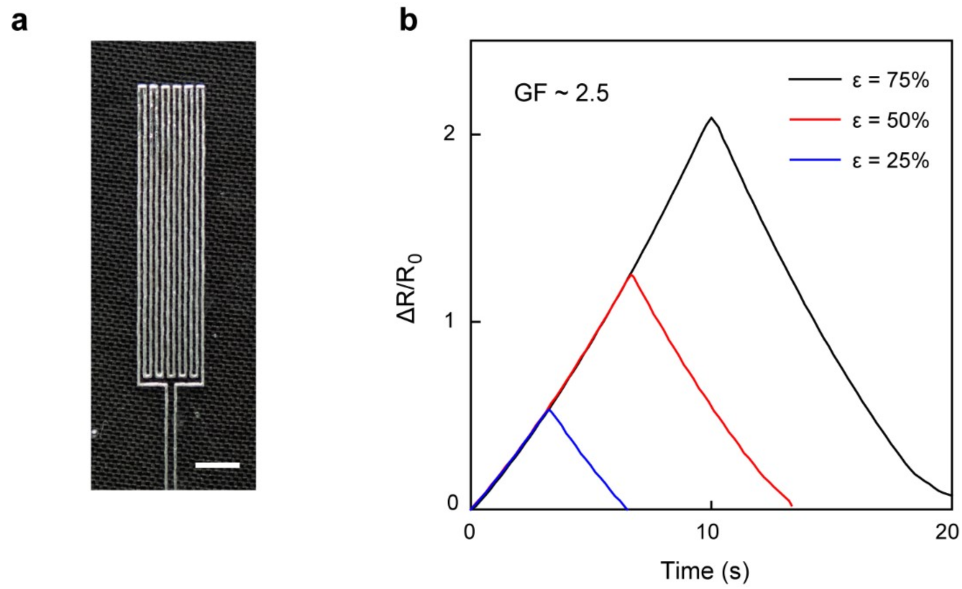

Fig. S8 a) Optical image of a representative strain sensor. Scale bar: 5 mm. b) Resistance change in response to uniaxial strain during loading/unloading conditions. The excellent symmetry suggests the absence of the hysteresis.

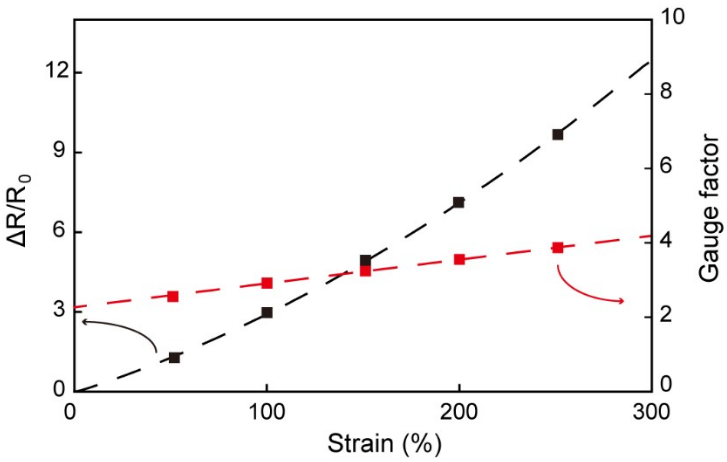

Fig. S9 Resistance change (black) and corresponding gauge factor (red) as a function of strain from 0 to 300%. A linear correlation between the gauge factor and the strain is expected for liquid-state sensors.[56, 57]

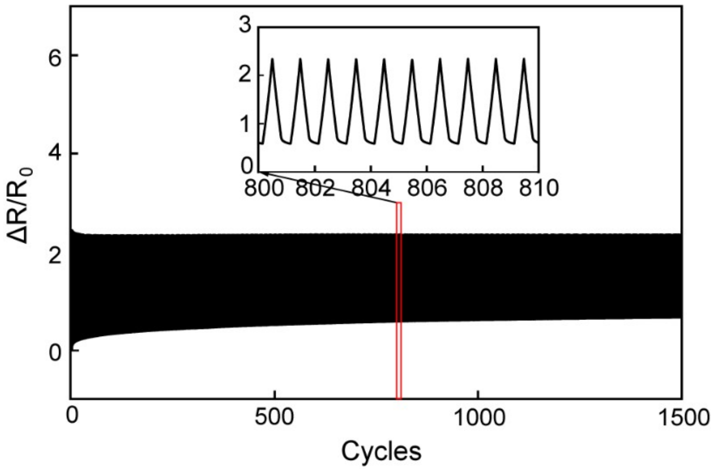

Fig. S10 Change in the normalized resistance during 1500 stretch-relaxation cycles to 100% strain.

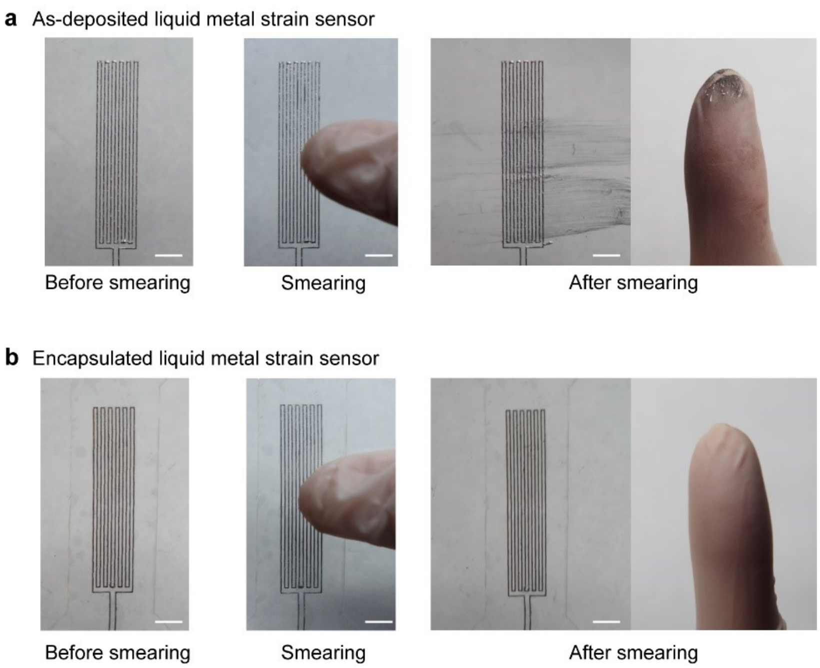

Fig. S11 Influence of the encapsulation on the structural stability of the liquid metal features. a) Optical images of an as-deposited liquid metal strain sensor subjected to rubbing test with a thumb. The pattern is obviously smeared as a result of the liquid-state nature. Scale bars: 5 mm. b) Optical images of an encapsulated liquid metal strain sensor subjected to rubbing test with a thumb. The intact morphology of the liquid metal feature demonstrates the protective effect of the encapsulation layer. Scale bars: 5 mm.

Supplementary Video

Video S1. Operation of an ultrastretchable ribbon cable as a deformable interconnect between an LED matrix display and a microcontroller board.

Video S2. Selective coating of liquid metal on screen-printed Ag nanocomposite feature in a dilute sodium hydroxide bath.