Supporting Information

Liquid Metal Sponges for Mechanically-Durable, All-Soft, Electrical Conductors

Suqing Liang, *Yaoyao Li*, *Yuzhen Chen, Jinbin Yang*, *Taipeng Zhu*, *Deyong Zhu, Chuanxin He*, *Yizhen Liu, Stephan Handschuh-Wang, and Xuechang Zhou* *

College of Chemistry and Environmental Engineering,
Shenzhen University, Shenzhen, 518060,P. R. China
Fax: (+) 86-755-26536141; Tel:(+) 86-755-26536627
E-mail: xczhou@szu.edu.cn (X. C. Z.)

Experimental

Preparation of the PDMS and liquid metal-filled PDMS sponges: PDMS sponges were prepared according to procedures describes previously.[1] Briefly, in a typical experiment, 50g PDMS prepolymer and 5g curing agent (Sylgard 184, Dow Corning) were mixed at a ratio of 10:1(weight ratio), and followed by immersing 6 sugar cubes (Tai Gang Food Co. Ltd, China). Afterward, the sugar cube-PDMS mixture was degassed in a vacuum chamber for 2 h. The sugar cube-PDMS mixture was solidified by curing at 65 ^{o}C at ambient pressure for 3 h. Afterward, PDMS on the surface was wiped off to expose the sugar. Subsequently, the sugar was dissolved under stirring in water at 60 ^{o}C, followed by rinsing with deionized (DI) water. Finally, PDMS sponges were obtained by drying at 100 ^{o}C at for 2 h. To fabricate liquid metal-filled PDMS sponges, the PDMS sponges were placed in a bath for 5 to 60 min containing the commercially available GaInSn liquid metals under vacuum.

Assembly of the LED circuits with GaInSn PDMS sponges: An array of GaInSn PDMS sponges was placed in a half-cured liquid elastomer (Ecoflex ® 00-30, Smooth-On), and then cured for 4 hours at room temperatures. Contacts of LED lamps were subsequently inserted into the GaInSn PDMS sponges, leading to the formation of flexible LED circuits with GaInSn PDMS sponges as interconnects.

Characterization: The morphology of the PDMS sponges and GaInSn Sponges was characterized with an optical microscope (SMZ18, Nikon), equipped with a CMOS camera.

The stretching and compression tests were conducted by using computer-controlled moving stages (PSA050, Zolix). The resistances of the GaInSn-PDMS sponges were measured by using a 4-point probe method with a Keithley 2400 sourcemeter. I-V characterization of the LED circuits was conducted by using a Keithley 2400 Multimeter GPIB remote control.

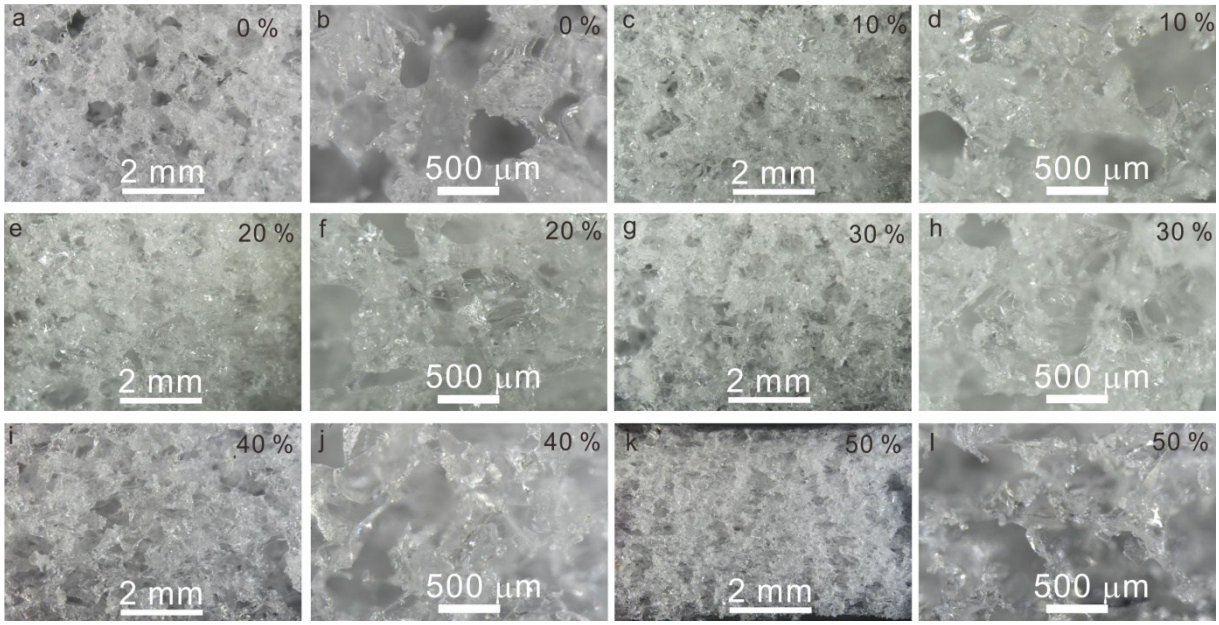

Figure S1. Optical micrographs of the PDMS sponges at different tensile strains: a-b) 0%, c-d) 10%, e-f) 20%, g-h) 30%, i-j) 40%, and k-l) 50%.

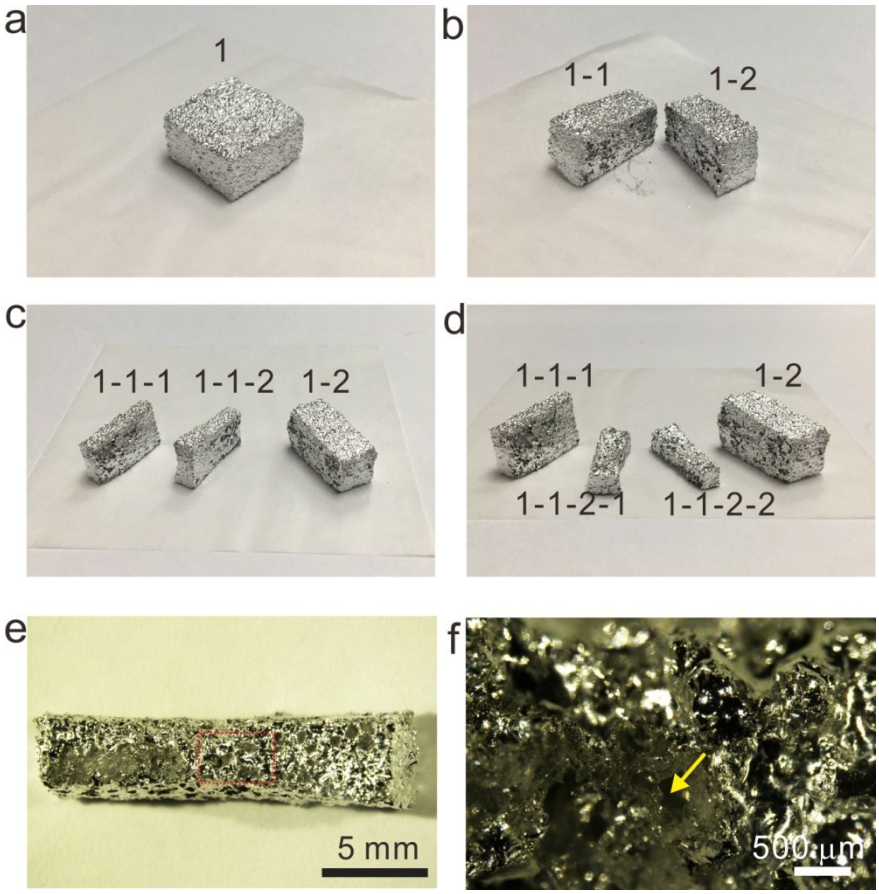

Figure S2. Digital images (a-d) and optical micrographs (e-f) of the liquid metal sponges with a density of 2.4 g/cm^3: (a) the original liquid metal sponges; (b) the sponges was cut into two pieces, 1-1 and 1-2; (c) the half-cut sponges (1-1) were then further cut into sponges 1-1-1 and 1-1-2; (d) the sponges (1-1-2) were cut into sponges 1-1-2-1 and 1-1-2-2. The digital images and optical microgaphs shows that the liquid metal spreads well within the sponges, and however, for a relative low loading, some empty pores are observed (see the arrow position in f).

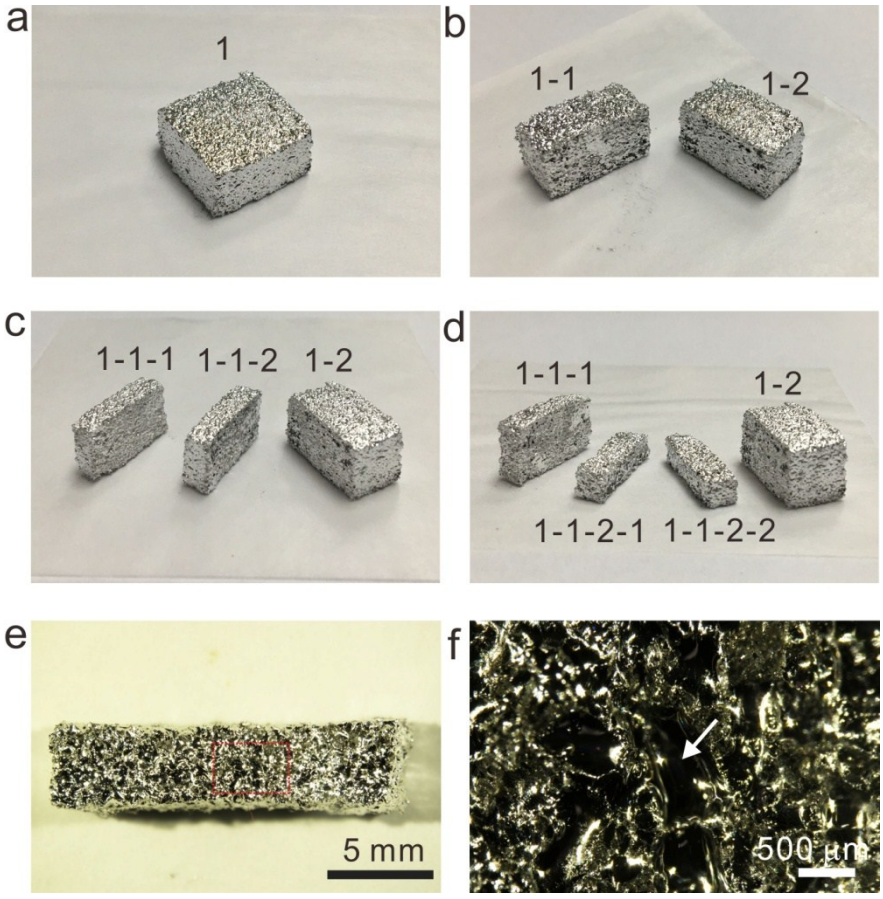

Figure S3. Digital images (a-d) and optical micrographs (e-f) of the liquid metal sponges with a density of 3.5 g/cm^3: (a) the original liquid metal sponges; (b) the sponges was cut into two pieces, 1-1 and 1-2; (c) the half-cut sponges (1-1) were then further cut into sponges 1-1-1 and 1-1-2; (d) the sponges (1-1-2) were cut into sponges 1-1-2-1 and 1-1-2-2. The digital images and optical microgaphs shows that the liquid metal spreads well within the sponges, and however, for a relative large loading, no empty pores are observed (arrow position in f shows the liquid metal-filled pores).

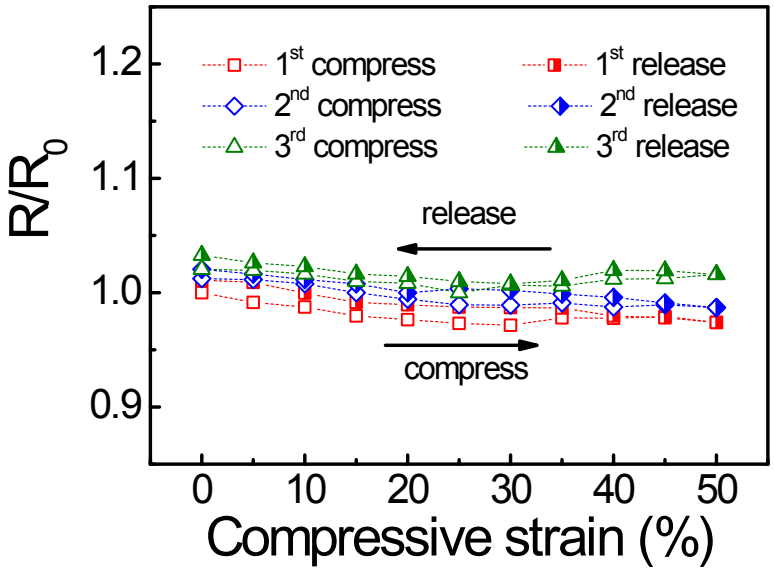

Figure S4. The normalized resistance variation of the rectangular-shape (Length = 12.5 mm, Width = 6.5 mm, Height = 11.5 mm) liquid metal sponges with an overall density of 1.77 g/cm^3 in the first three cycles of compression and release from 0 to 50%.

Reference

[1] S. Q. Liang, Y. Y. Li, J. B. Yang, J. M. Zhang, C. X. He, Y. Z. Liu, X. C. Zhou, Adv. Mater. Technolo. 2016, 1, 1600117.