

Supplementary material

Electromagnetic Three-dimensional Liquid Metal Manipulation

Jinwon Jeong^a, Jeong-Bong (J.-B.) Lee^b, Sang Kug Chung^{a*} and Daeyoung Kim^{c*}

^a Department of Mechanical Engineering, Myongji University, Yongin, Republic of Korea.

^b Department of Electrical Engineering, The University of Texas at Dallas, Richardson, USA.

^c Department of Information and Communication Engineering, Korea Army Academy at Yeong-cheon, Republic of Korea.

1. Gold Pattern Fabrication for electrical switch test

To test switching functionality of the magnetic liquid metal marble actuated by electromagnets, we designed and fabricated gold (Au) metal pattern which was made by photolithography process and linked to three different light emitting diodes (LEDs), as shown in Figure S1. First, we deposited chromium (thickness of 40 nm) for a sacrificial layer and gold (thickness of 100 nm) on a slide glass (7.5 (L) x 2.5 (W) cm) through sputtering (Figure S1a,b). Then, for the photolithography, we coated positive photoresist (AZ[®] 7220PR) on the gold layer using a spin coater (Figure S1c). Second, using a designed mask to pattern a circuit of switches and a mask aligner (MDA-400M, Midas System Co., Ltd), the photoresist layer was patterned, developed by a photoresist developer (AZ[®] 300 MIF Developer), and hard-baked for 20 minutes at 150 °C (Figure S1d, e, f). Third, we etched gold and chromium using etchants. Finally, the photoresist layer which was exposed to UV light was removed using photoresist developer.

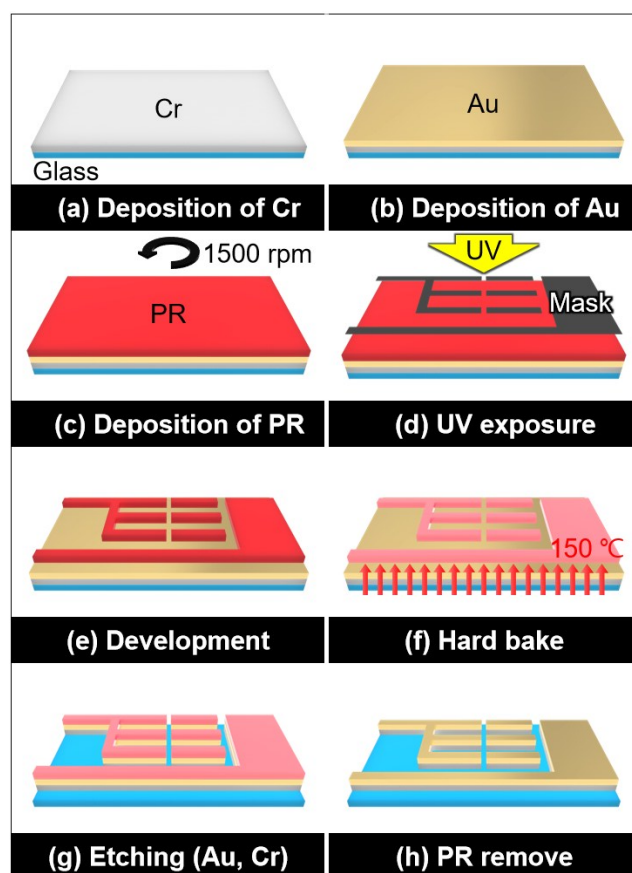


Figure S1. Schematic of fabrication process of gold pattern to demonstrate the electrical switch application using the magnetic liquid metal marble on-demand controlled by electromagnets.