

## Support Information

### Electrical control of liquid metal amoeba with directional forming extensions

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### **The multi-material interaction in liquid metal amoeba-like transformations<sup>1</sup>**

The LM-Al droplet transformation on the graphite plate refers to a complex multi-material system including LM, Al, graphite and the alkaline electrolyte surrounding them. In brief, the interaction with graphite plate can decrease the surface tension of LM droplet while the Al reaction increases the surface tension. To be more detailed, it has been disclosed that the interaction with graphite surface could induce the surface oxide formation on the LM droplet due to the electrochemical effects<sup>2</sup>. The surface oxide can significantly reduce the surface tension of LM droplet. On the other hand, the Al on the LM droplet would form galvanic cell with the graphite substrate through the LM, since there are potential differences between those conductive materials. Al in the LM-Al droplet should work as anode, which initially react and lose electrons ( $Al + 4OH^- - 3e = AlO_2^- + 2H_2O$ ). Then electrons outflowed to the graphite through the LM. Thus the surface oxide on the LM can be reduced in some extent ( $Ga^{3+} + 3e = Ga$ ). Then the surface tension regained in this way. At the anode (graphite), water should receive those electrons and hydrogen is produced ( $2H_2O + 2e = H_2\uparrow + 2OH^-$ ). Besides, with surface oxide, the surface tension of the droplet is much lower than that without surface oxide. Thus the droplet is more deformable. The dynamic interaction with Al and graphite could induce the surface tension imbalance along the droplet, which leads to the transformation as a result.

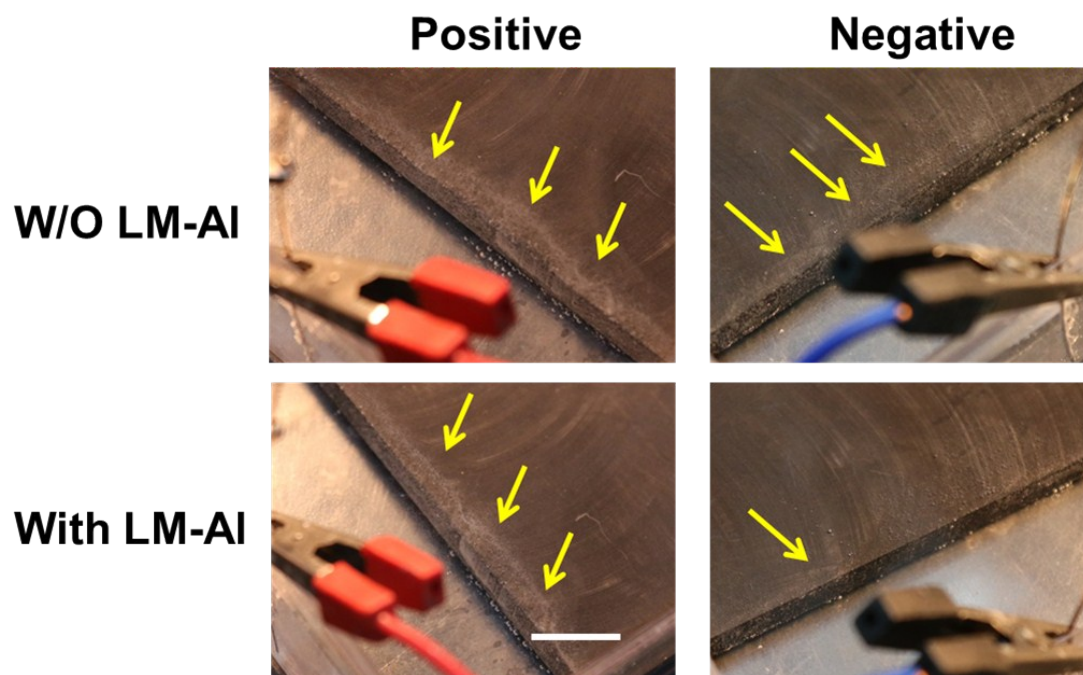


Figure S1. The graphite plate in the electric field. The left two images are graphite plate edges facing the positive pole. The right two are facing the negative pole. In the upper two images no LM-AI droplet was placed on the plate. In the lower two there are LM-AI droplets on the plate. Yellow arrows indicate the gas generating on the edges.

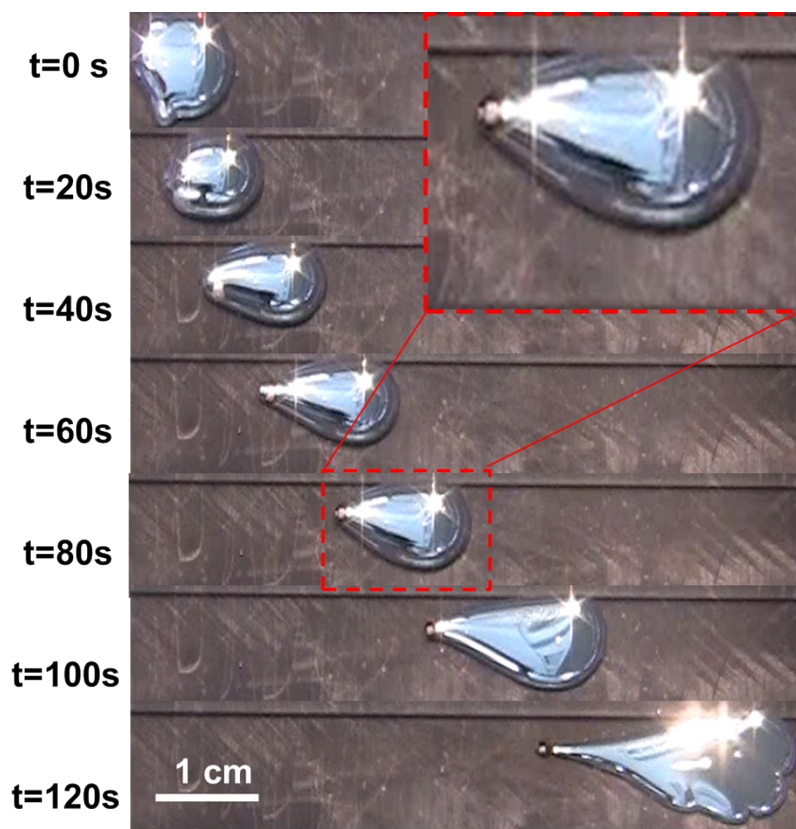


Figure S2. The LM droplet move on the graphite surface in the electric field<sup>5</sup>.

## Supplementary Movie

### Movie S1

The surface flow rolling from left to right along the electric field line.

### References

- <sup>1</sup> L. Hu, B. Yuan, and J. Liu, *Scientific Reports* **7** (1), 7256 (2017).
- <sup>2</sup> Liang Hu, Lei Wang, Yujie Ding, Shihui Zhan, and Jing Liu, *Advanced Materials* **28** (41), 9210 (2016).