Electronic Supplementary Material (ESI) for Nanoscale.

Sculpting Liquid Metal Stabilized Interfaces: A Gateway for Liquid Electronics.

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Supporting Information

Materials

Iron(III) acetylacetonate [$Fe(acac)_3$], manganese(III) acetylacetonate [$Mn(acac)_3$] and cobalt(III) acetylacetonate [$Co(acac)_3$] purchased from TCI. Tannic acid (TA) was purchased from HIMEDIA. Gallium Indium eutectic, 99.99% purchased from Alfa Aesar. 1,2-dichlorobenzene was purchased from TCI. Grubbs Catalyst and Dicyclopentadiene was purchased by Sigma-Aldrich. Millipore water (18.2 MΩ•cm at 25 °C) was used in all interfacial tension measurements.

Characterization: The dynamic interfacial tension (γ) was analysed by a tensiometer (Drop Shape Analyzer – DSA25 - KRÜSS GmbH) using[i] a pendant-drop method, where the evolution of γ with time was recorded after the oil phase (1,2-dichlorobenzene) was slowly injected into the aqueous phase. The volume of the oil droplet was fixed to 10µl for all the experiments. The deformation and wrinkling behaviour were recorded as images or videos with a digital camera. NPs size distribution was obtained by transmission TEM (JEM-2100, JEOL, Japan). The FE-SEM (JSMIT-300, JEOL, Japan) was employed to obtain the surface morphology. The quantitative elemental analysis was carried out by XPS (K-Alpha, Thermo Fisher Scientific, USA). The attachment of TA with Ga NPs was confirmed by using the Thermo Scientific Nicolet iS20 FTIR instrument. Keysight B1500A semiconductor analyzer with SMU B1511B and SMU B1510A are used for low-power and high-power measurement respectively.

Electrical Measurements setup

At room temperature and ambient conditions, all the electrical measurements are performed. In the probe station, two probes are connected to measure the electrical properties of the Ga-Nanoparticle. Keysight B1500A semiconductor analyzer with SMU B1511B and SMU B1510A are used for low-power and high-power measurement respectively. In-situ conductivity measurement of the nanoparticle at the time of HCl treatment is done by an in-house developed set-up which is illustrated in HCl fumes prepared by the non-reactive gas (N_2) as carrier gas passes through a container with 5 mL of concentrated HCl. The flow of the carrier gas is controlled through a mass flow controller and fixed value at 50 Sccm.

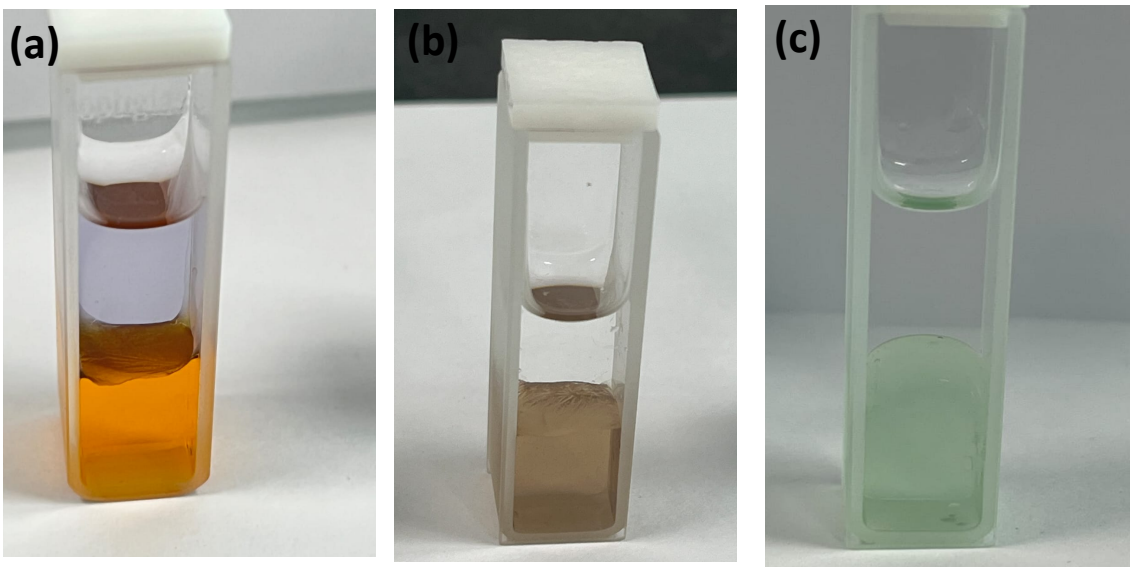

Figure S1. Snapshots showing the interfacial film of a) $Fe(acac)_3$/TA b) $Mn(acac)_3$/TA c) $Co(acac)_3$ /TA**.**

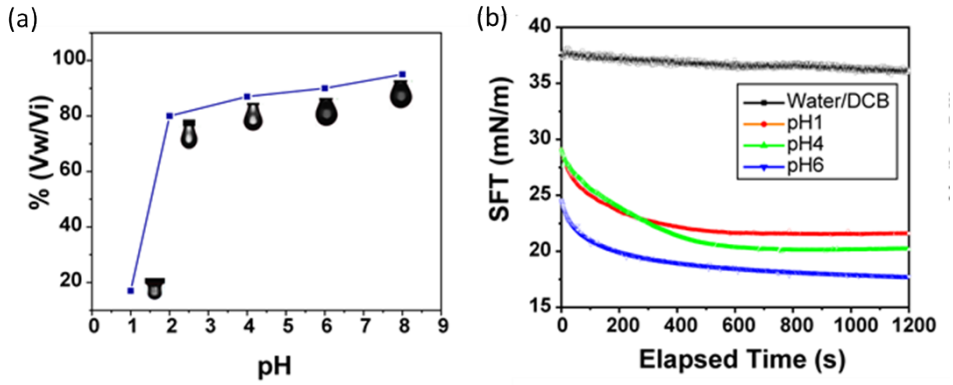

Figure S2. (a) Surface coverage of Fe^{III} (1 mM) varying different pH of TA (1 mg/mL). (b) Time evolution interfacial tension at different pH.

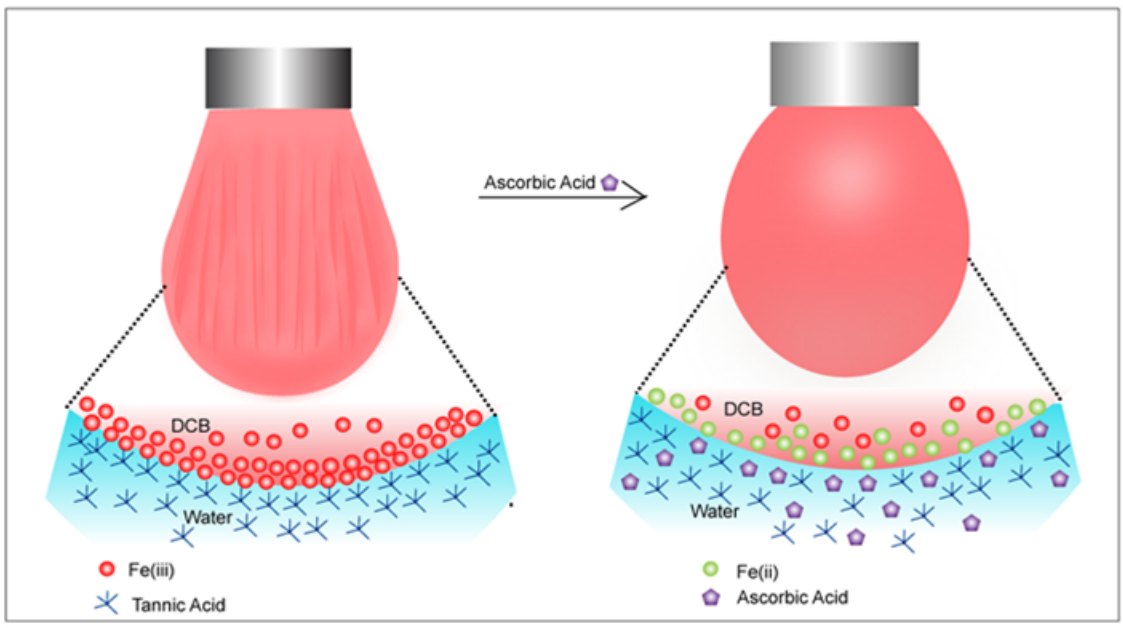

Figure S3. Ascorbic acid-mediated reductive assembly.

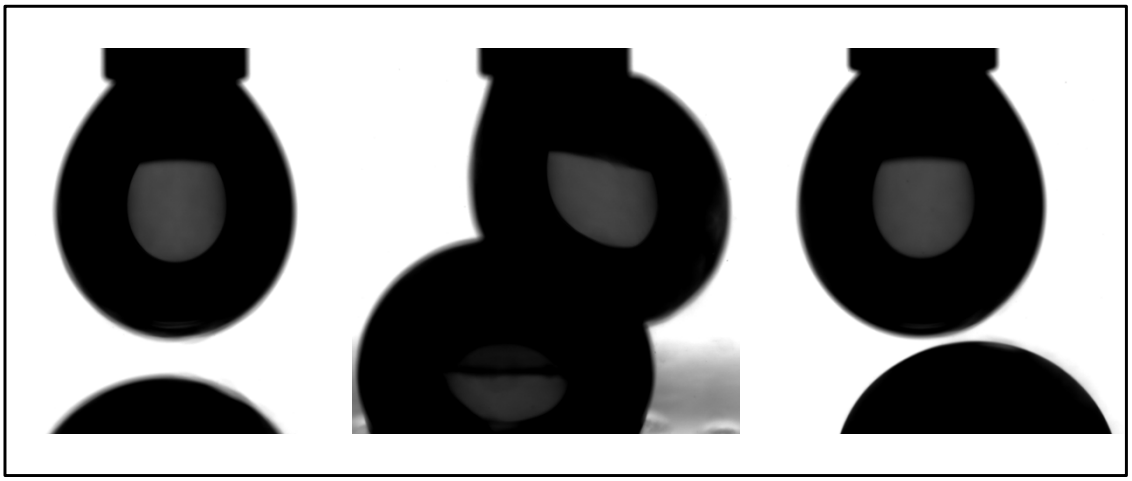

Figure S4. Snapshots showing the process of contact, compression, and separation of two droplets.

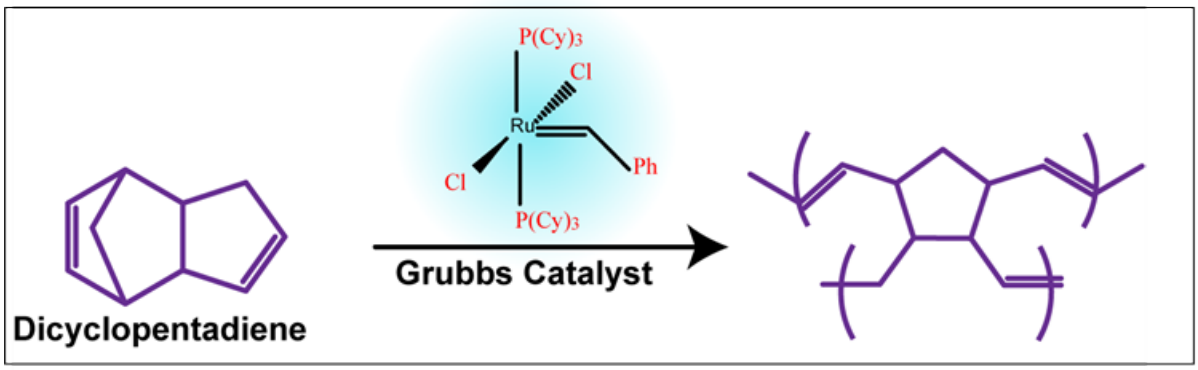

Figure S5. Polymerization reaction of dicyclopentadiene (DCPD) and Grubbs catalyst.

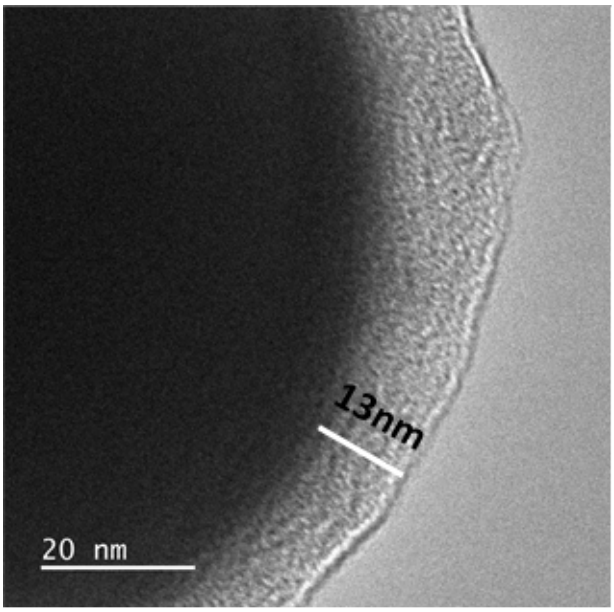

Figure S6. TEM image of Ga NPs.

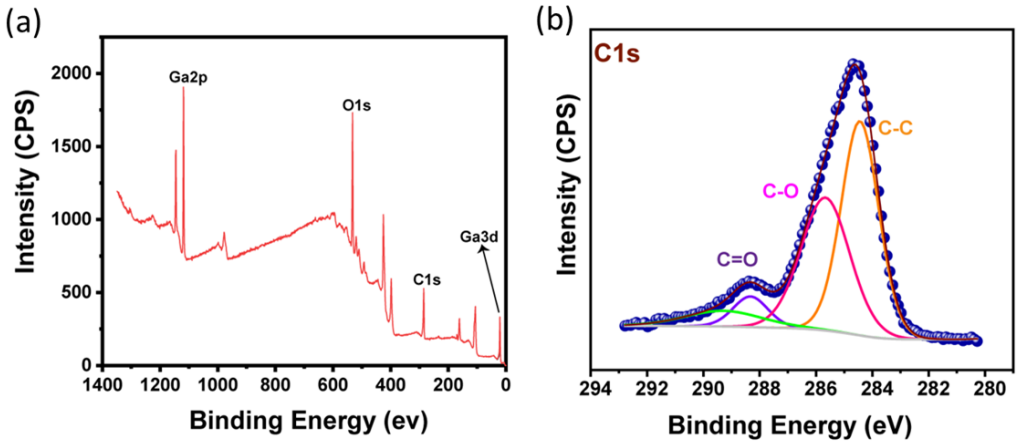

Figure S7. (a) XPS survey of Ga NPs. (b) XPS survey of $C_{1s.}$

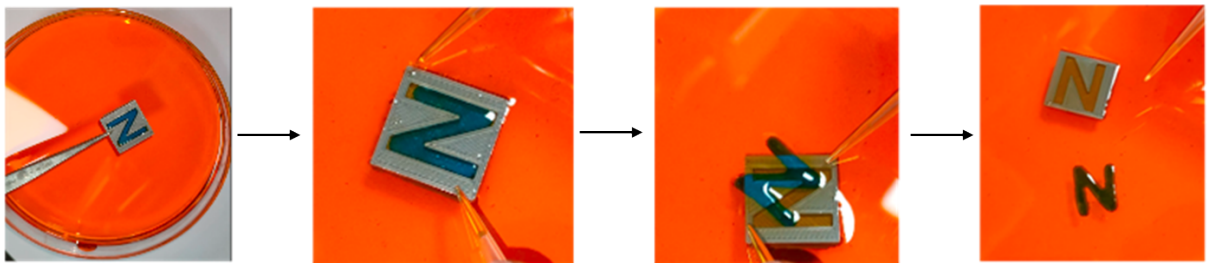

Figure S8. Snapshots of liquid letter formation.

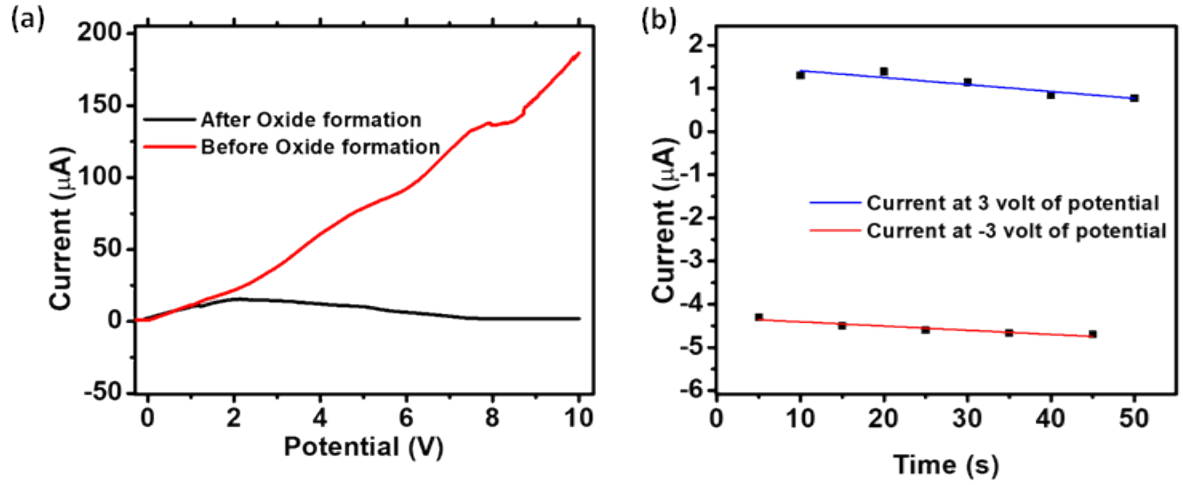

Figure S9. (a) I-V variation of the thick and thin oxide layer. (b) At ±3 volt of sweep voltage with holding of 5 sec current-time characteristic, where conductivity slightly decreased.