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Supporting Information

Water Processable Liquid Metal Nanoparticles by Single Step Polymer Encapsulation

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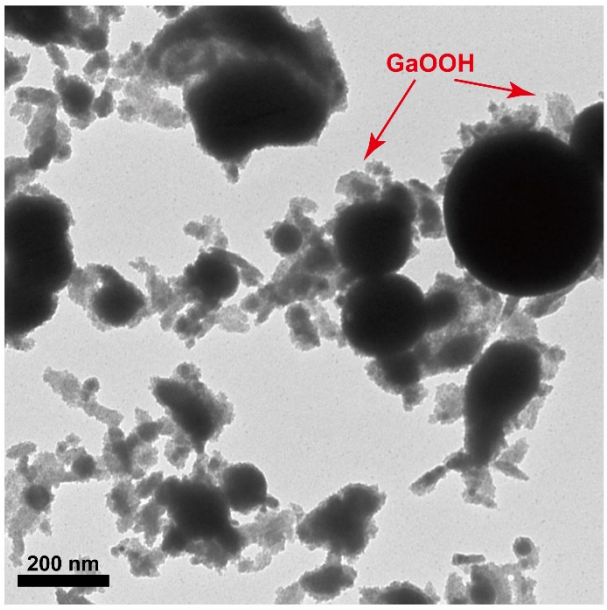


Figure S1. Representative TEM image of EGaIn NPs (100 mg EGaIn) synthesized in water showing the adsorbed GaOOH particles. Scale bar: 200 nm.

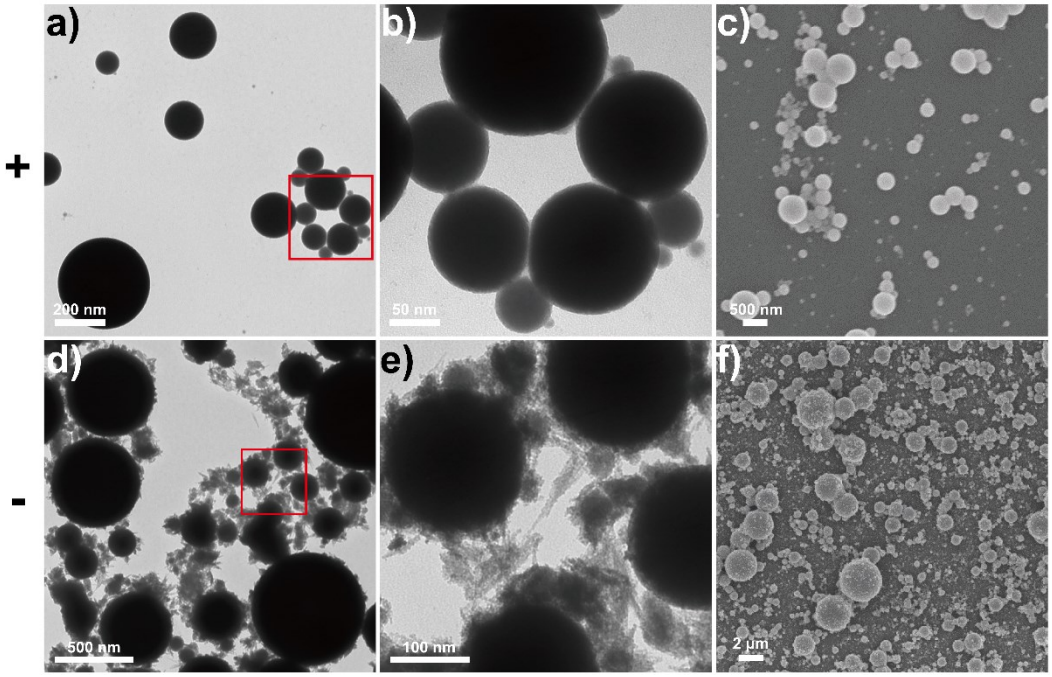


Figure S2. Synthesis of EGaIn NPs (1 g EGaIn) with (+) and without (-) the addition of PVP (10 wt%). (a-b) TEM images of EGaIn@PVP NPs. (c) SEM image of EGaIn@PVP NPs. (d-e) TEM images of EGaIn NPs. (f) SEM image of EGaIn NPs. Scale bar: 200 nm in (a), 50 nm in (b), 500 nm in (c-d), 100 nm in (e), 2 µm in (f).

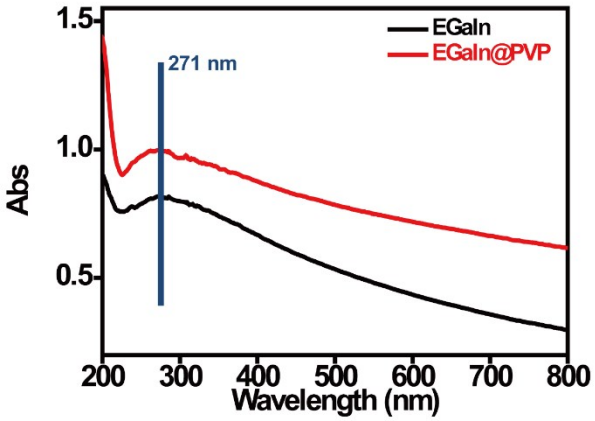


Figure S3. UV-Vis spectra of EGaIn NPs and EGaIn@PVP NPs.

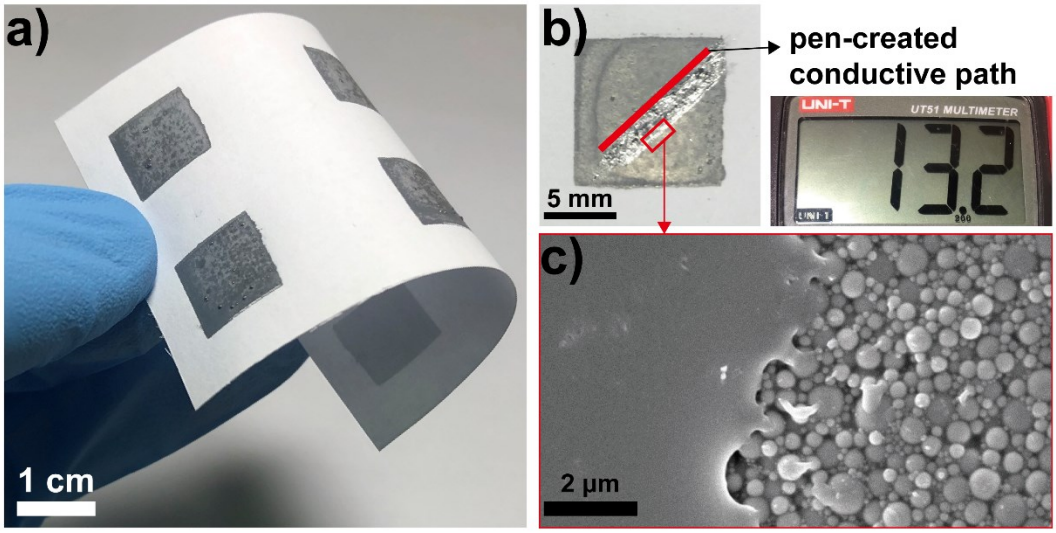


Figure S4. Screen printing and mechanical sintering of EGaIn@PVP NPs. (a) Digital photograph of patterned EGaIn@PVP NPs. The NPs are prepared by sonicating 1 g EGaIn in 10 wt% PVP and printed on a A4 paper using a screen printer. (b) Conductive path created by compressive writing using a marker pen. (c) SEM image of the sintered EGaIn@PVP NPs. Scale bar: 1 cm in (a), 5 mm in (b), 2 µm in (c).

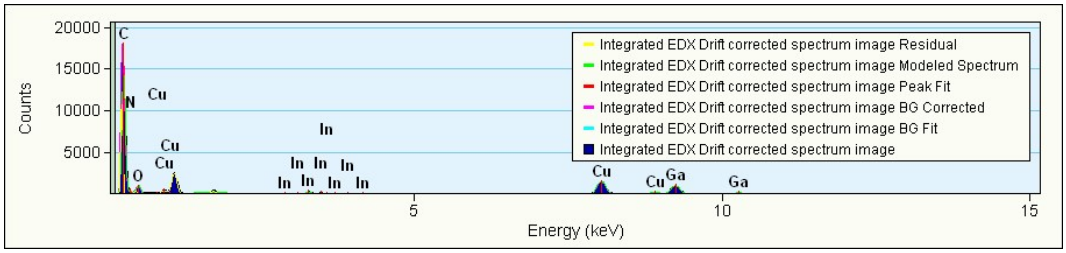
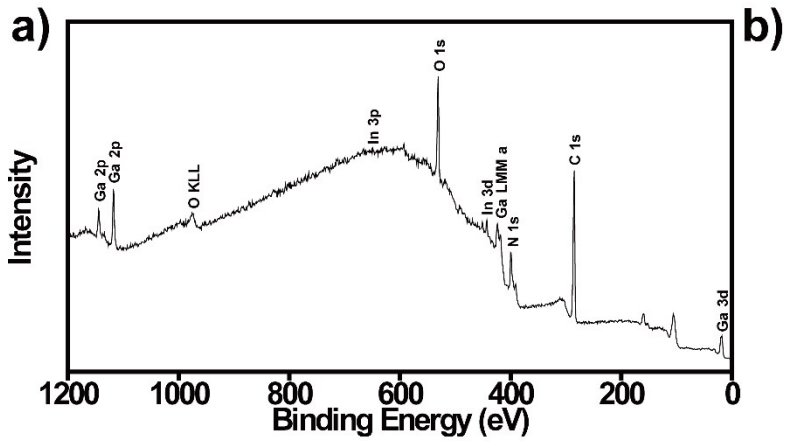


Figure S5. TEM EDX spectrum of EGaIn@PVP NPs.



Element	At%
C	50.19
N	14.68
O	11.31
Si	23.02
Ga	0.64
In	0.16

Figure S6. (a) XPS spectrum of EGaIn@PVP NPs. (b) Atomic ratio (at%) of different elements in EGaIn@PVP NPs.

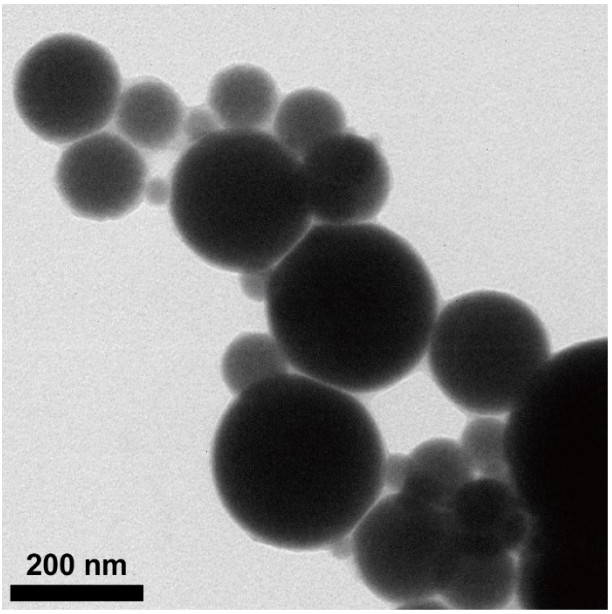


Figure S7. TEM image of EGaIn@PAA NPs synthesized in a Tris-HCl buffer (pH 6.8). Scale bar: 200 nm.

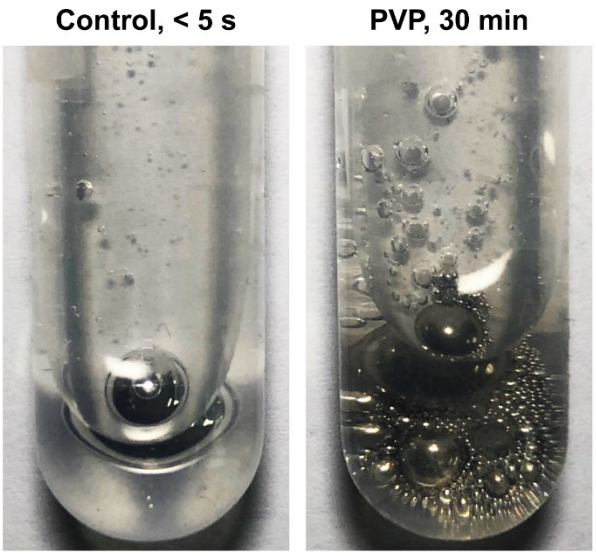


Figure S8. Interaction of PVP with pure EGaIn. 100 μL EGaIn is placed in 1 M HCl without (a) or with (b) 1 wt% PVP and mixed by hand shaking.

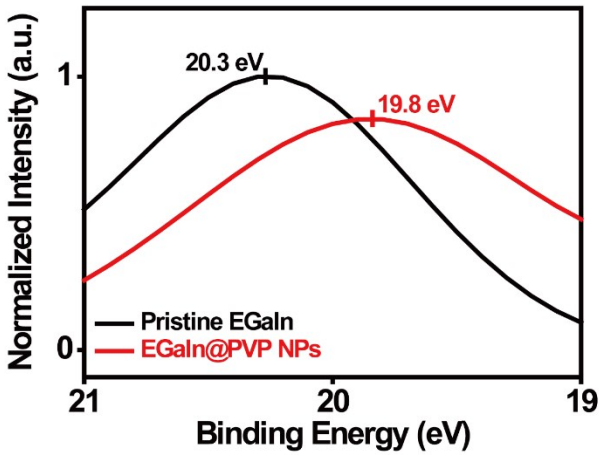


Figure S9. XPS spectra showing the Ga 3d peak of pristine EGaIn and EGaIn@PVP NPs.

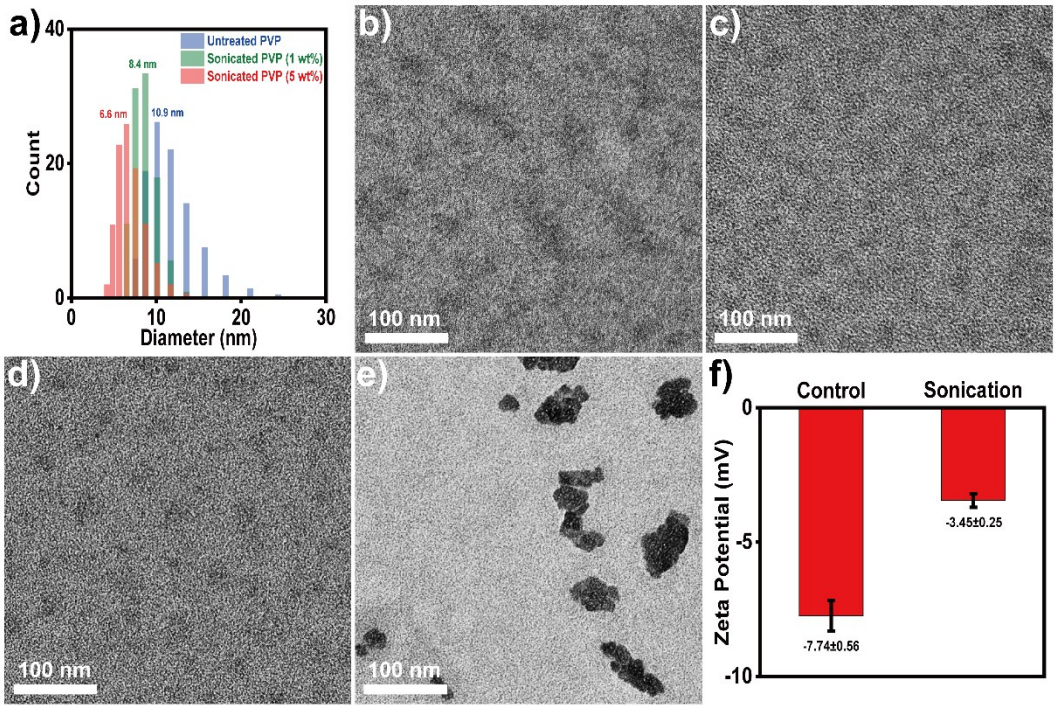


Figure S10. Effect of sonication on the size and morphology of PVP molecules. (a) Size distributions of untreated PVP and sonication-processed PVP, measured by DLS. (b-d) Representative TEM images of untreated PVP (b), 1 wt% PVP after sonication (c), and 5 wt% PVP after sonication. (e) TEM image showing large polymer fragments in 5 wt% PVP after sonication. (f) Zeta potential of untreated PVP (1 wt%) and sonication-treated PVP (1 wt%). Scale bar: 100 nm in (b-e).

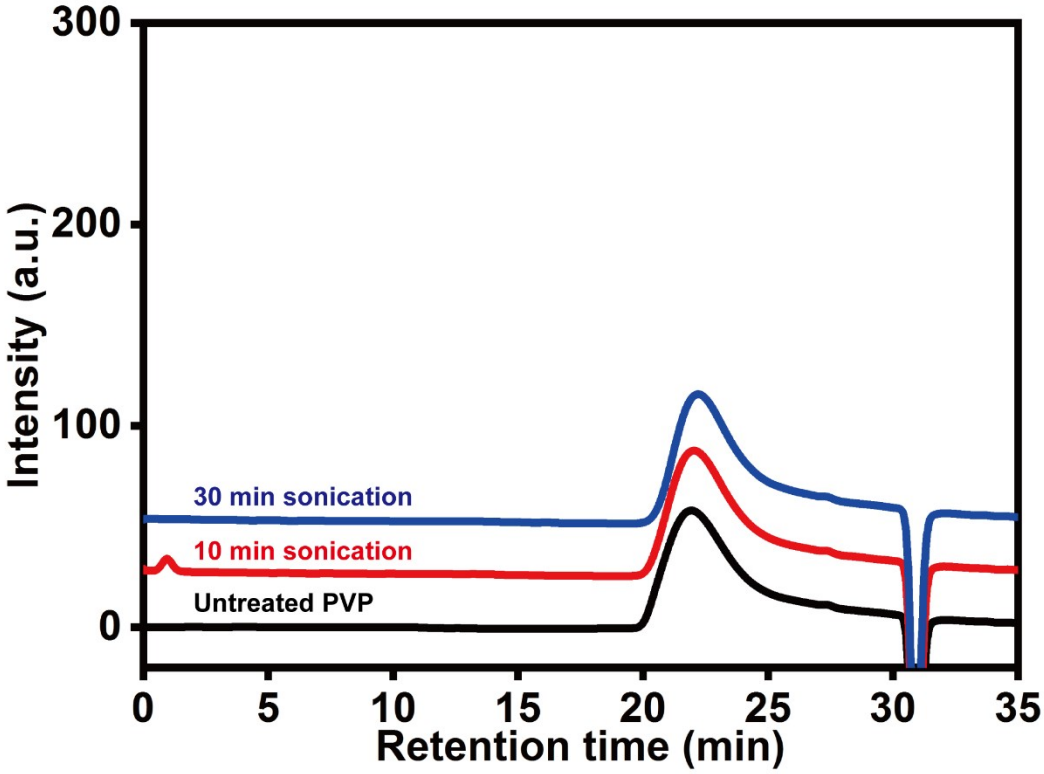


Figure S11. Size exclusion chromatograms of PVP (molecular weight: 40 kD) before (black line) and after sonication treatment for 10 min (red line) and 30 min (blue line).

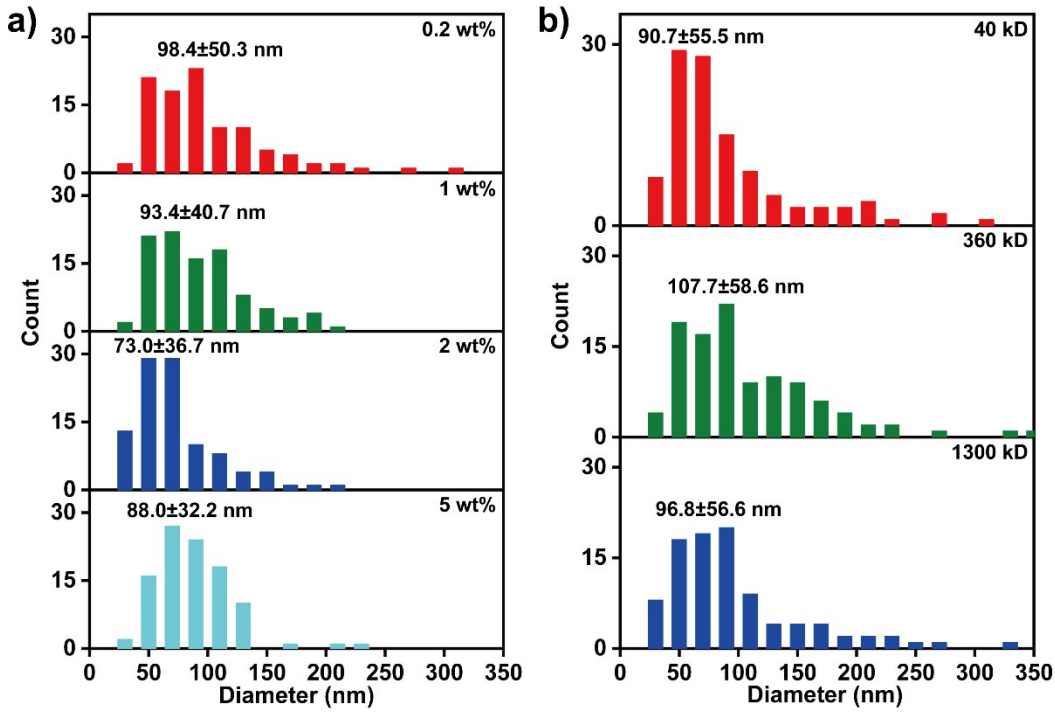


Figure S12. TEM size distribution of EGaIn@PVP NPs synthesized with different polymer concentrations (using PVP 40kD) (a) or molecular weights (using 1 wt% polymer) (b).

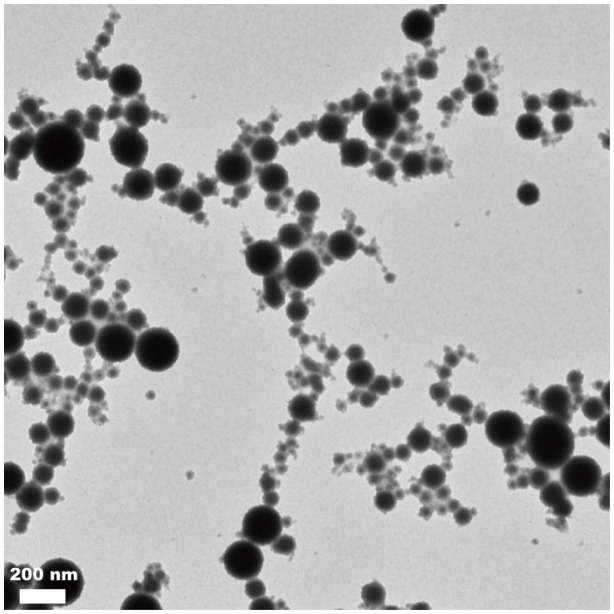


Figure S13. Low magnification TEM image of EGaIn@PVP NPs prepared with 100 mg EGaIn and 2 wt% PVP. The yield (Y) of successful encapsulation is estimated by the number (N) percent of encapsulated LM NPs. $Y = N_{Encapsulated}/N_{Total}$. Scale bar: 200 nm.

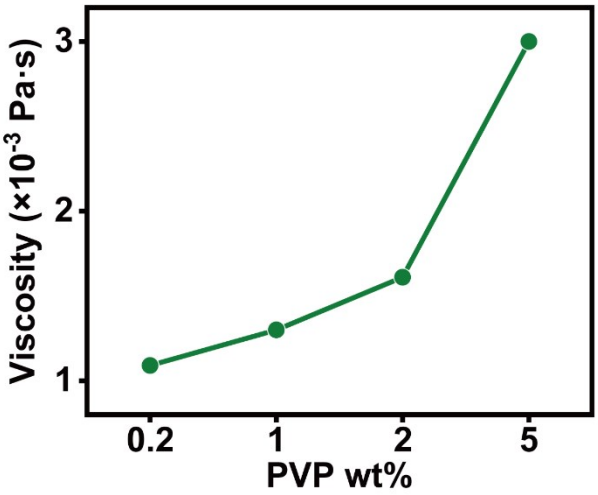


Figure S14. Viscosity of PVP solutions at different concentrations.

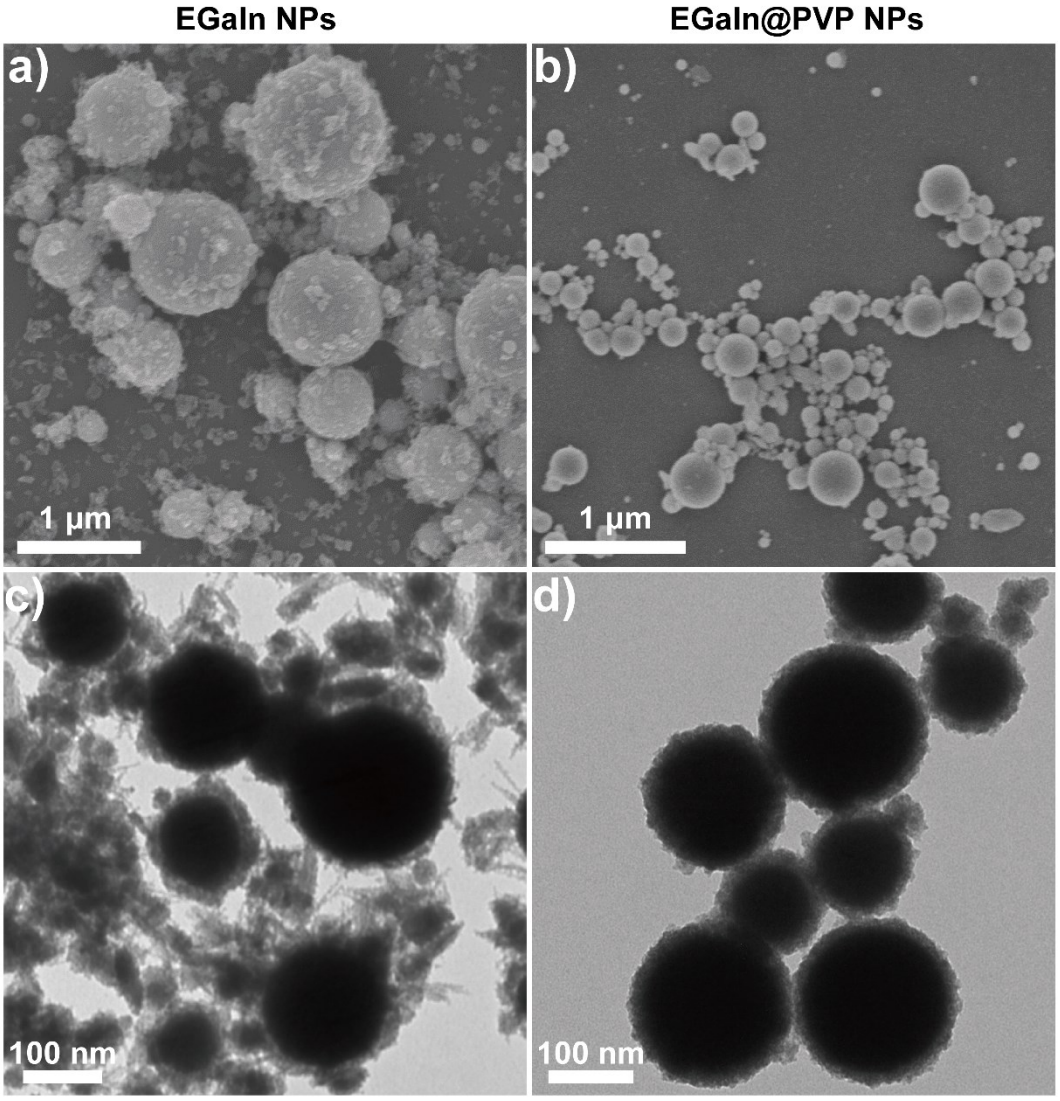


Figure S15. Stability test of EGaIn NPs and EGaIn@PVP NPs in water. (a-b) SEM images of EGaIn NPs (a) and EGaIn@PVP NPs (b) preserved in water for 48 h. (c-d) TEM images of EGaIn NPs (c) and EGaIn@PVP NPs (d) preserved in water for 48 h. Scale bar: 1 μm in (a-b), 100 nm in (c-d).

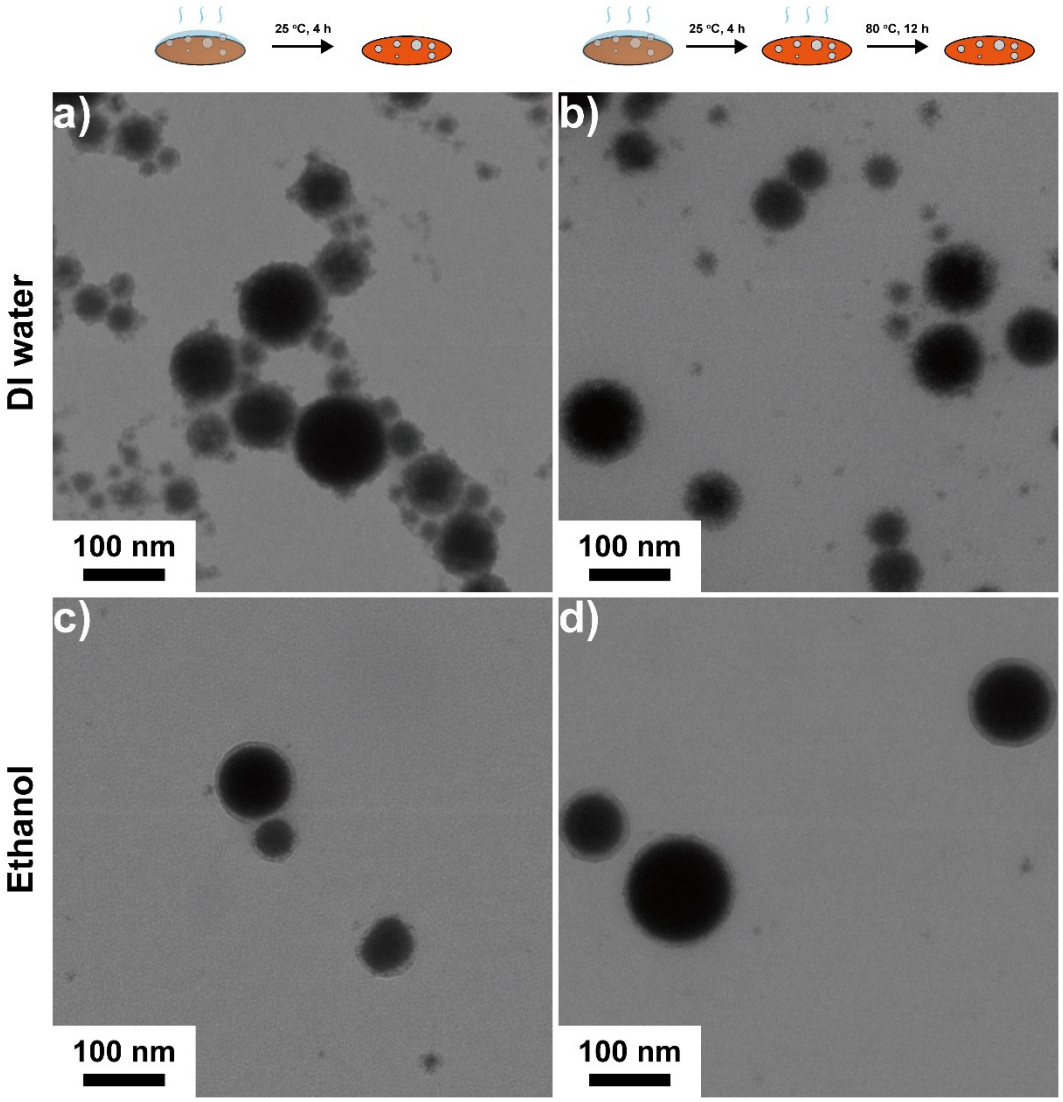


Figure S16. TEM images of EGaIn@PVP NPs dispersed in water and ethanol using different sample preparation steps. The copper grid is heated at 80 °C for 12 h for (b) and (d). Scale bar: 100 nm in (a-d).

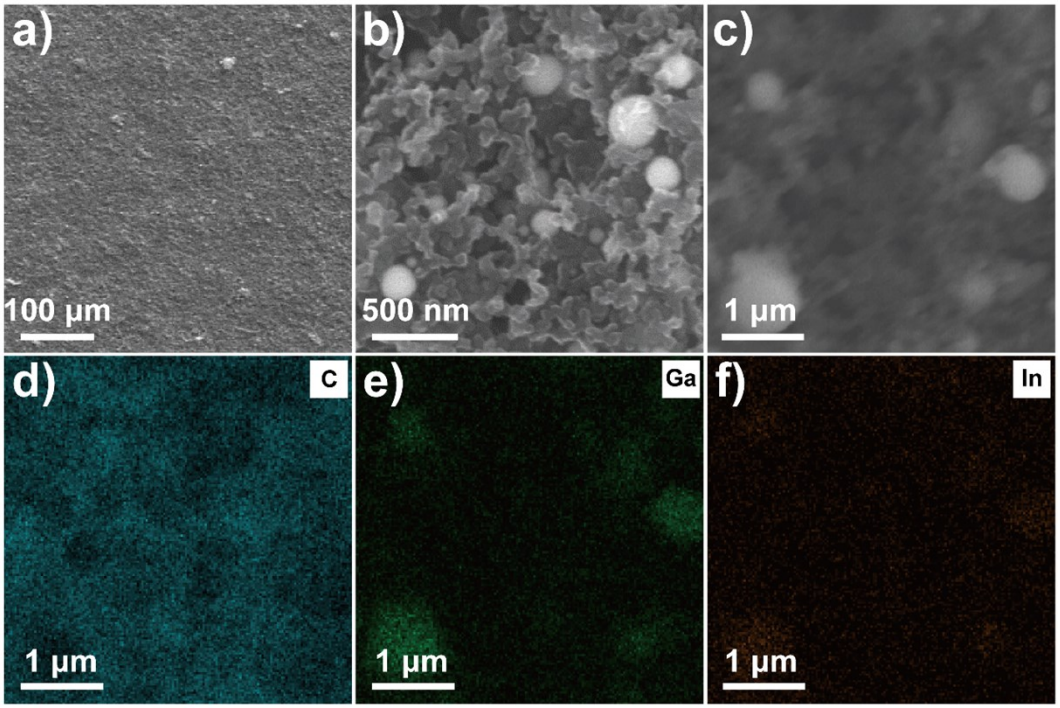


Figure S17. SEM characterization of the EGaIn@PVP NPs electrode. (a-b) SEM images under low (a) and high (b) magnifications. (c-f) SEM EDX mapping of various elements including C (d), Ga (e), and In (f). Scale bar: 100 μm in (a), 500 nm in (b), 1 μm in (c-f).

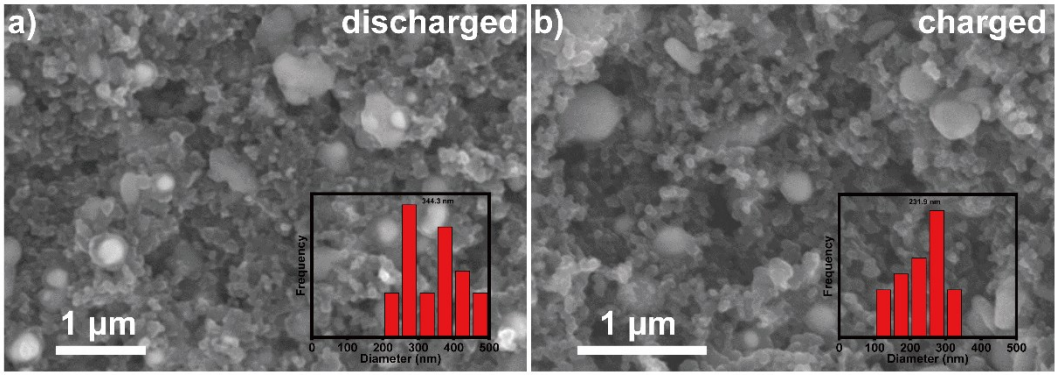


Figure S18. SEM images of the LM electrode at discharged state (a) and charged state (b). Scale bar: 1 μm in (a-b).