Virus templated metallic nanoparticles.

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Supplementary Information

Instrumentation

- Transmission Electron Microscope (TEM) – FEI Tecnai 20 TEM, FEI UK Ltd, Cambridge.
- Energy Dispersive X-ray Spectroscopy (EDXS) – OXFORD INCA Energy 200 Premium.
- Dynamic Light Scattering (DLS) – DynaPro Titan, Wyatt Technology Corporation.
- Zeta Potential (ZP) – Malvern Instruments Zetasizer-Nano ZS.
- AFM Asylum Research MFP 3D mounted on Olympus IX71 inverted optical microscope
- UV-vis Spectrometer – Perkin Elmer Lambda 25

General Methods

Cowpea mosaic virus (CPMV) purification

CPMV was purified from infected *Vigna unguiculata* (black-eyed pea) leaves using a modified protocol (http://www.dpvweb.net/dpv/showdpv.php?dpvno=197). Particle integrity was investigated by TEM and agarose gel electrophoresis and the concentration was determined photometrically; the molar extinction coefficient of CPMV at a wavelength of λ = 260 nm is ε = 8.1 ml mg^{-1} cm^{-1}.

Transmission Electron Microscopy (TEM)

Purified samples were transferred into Milli-Q water using 100 kDa cut-off columns (Microcon), allowed to settle briefly onto pyroxylin and carbon-coated copper grids and then blotted dry. For negative staining, 2% uranyl acetate solution was used. Grids were viewed at 200 kV in an FEI Tecnai20 TEM (FEI UK Ltd, Cambridge) and images were obtained using a bottom-mounted AMT XR60 CCD camera (Deben UK Ltd, Bury St. Edmunds).

Dynamic Light Scattering (DLS)

Diluted samples (13 µl), at approximately 0.5 mg/ml in sodium phosphate buffer (10 mM) pH 7.0 were filtered through 0.1 µm filters (Millipore) prior to analysis. Measurements were taken every 10 seconds, and 10 measurements were averaged from 3 runs at 21 °C.

Zeta potential

1 ml of 0.5 mg/ml metallized-CPMV particles dispersed in sodium phosphate buffer (10 mM) pH 7.2 was prepared. Zeta cells were equilibrated at 21 ºC for two minutes before recording three measurements each of ten runs. Data was collected with automatic attenuation selected and analysed using the Smoluchowski module.

Agarose Gel Electrophoresis

5-10 µg of CPMV particles suspended in sodium phosphate buffer (10 mM) pH 7.0 with 2 µl of loading dye (Coomassie staining solution) were analysed on 1.2 % (w/v) agarose gel in an electric field of 60 V for 1-2 hours. For ethidium bromide staining, 0.1 µg/ ml (4-5 µl) in 1x TBE buffer was added to the gel. Particles were visualised on a UV transilluminator at 302 nm using Gene Genius Bio Imaging System with software Gene Snap (Syngene). For coat protein staining, gels were treated with Coomassie staining solution (50 % (v/v) methanol; 10 % (v/v) acetic acid; 0.25 % (w/v) Coomassie Brilliant Blue G-250) for 1 hour followed by destaining solution (20 % (v/v) methanol; 7.5 % (v/v) acetic acid in MilliQ water) overnight. Gel images were recorded using camera or scanner.

Supplementary Information Figures

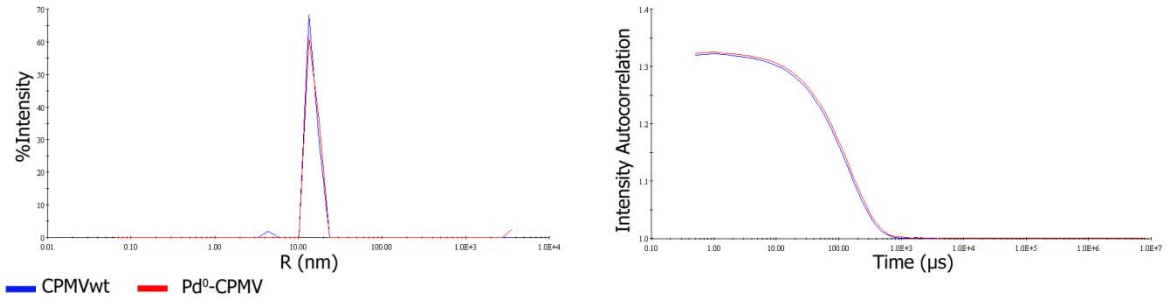

Figure S-1. DLS, hydrodynamic radius (left) and correlation plots (right) comparing wild-type CPMV (blue line) and Pd^0-CPMV particles (red line).

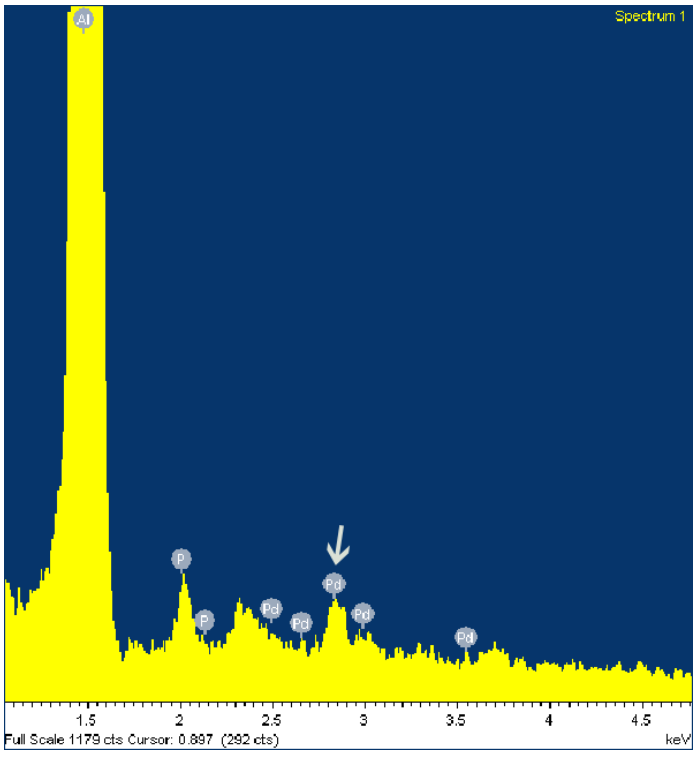

Figure S-2. EDX spectrum of Pd^0-CPMV particles. Main palladium peak indicated by arrow.

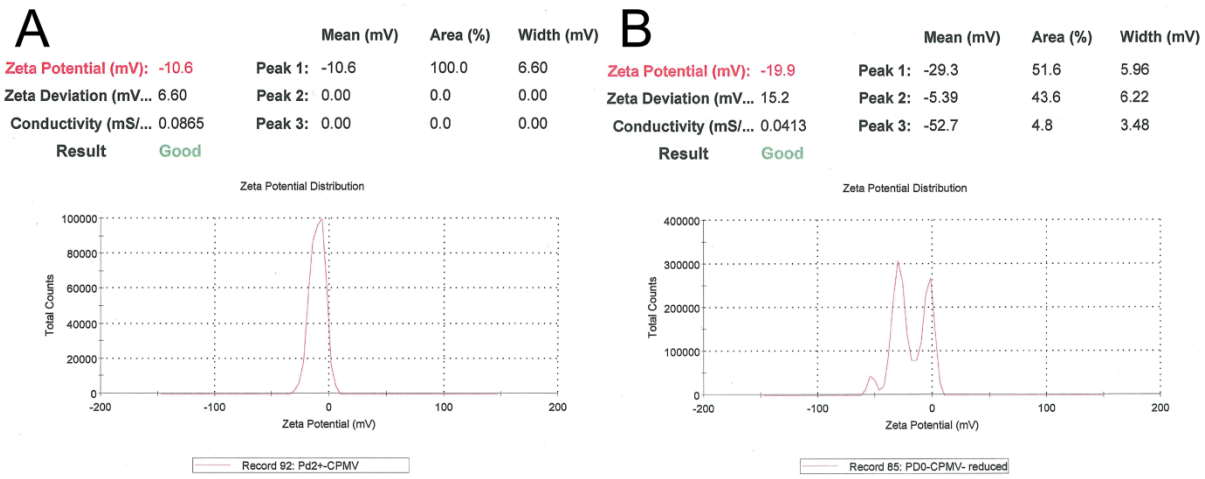

Figure S-3. Zeta potential measurement in buffer at pH 7.0 of (A) Pd^{2+}-CPMV particles, (B) Pd^{0}-CPMV particles.

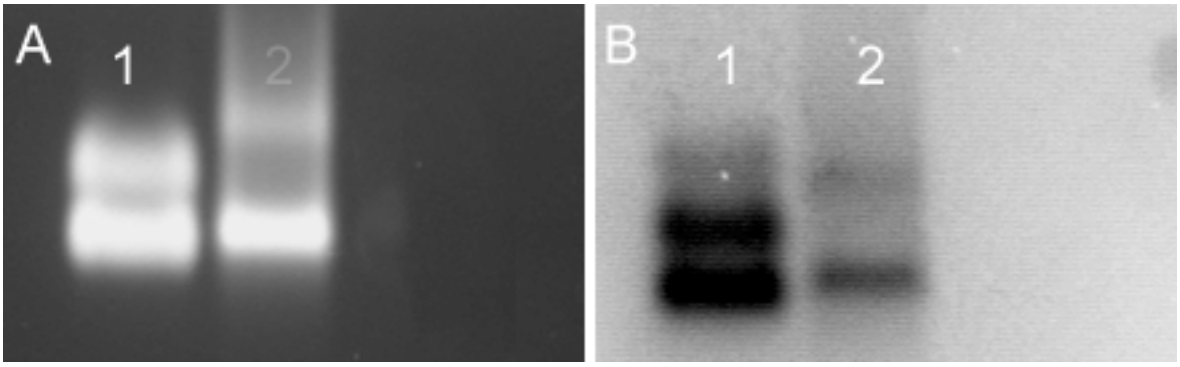

Figure S-4. Agarose gel (1.2%) of CPMV particles visualised by (A) ethidium bromide staining, (B) Coomassie staining. Lane 1, wild-type CPMV; 2, Pd^{0}-CPMV.

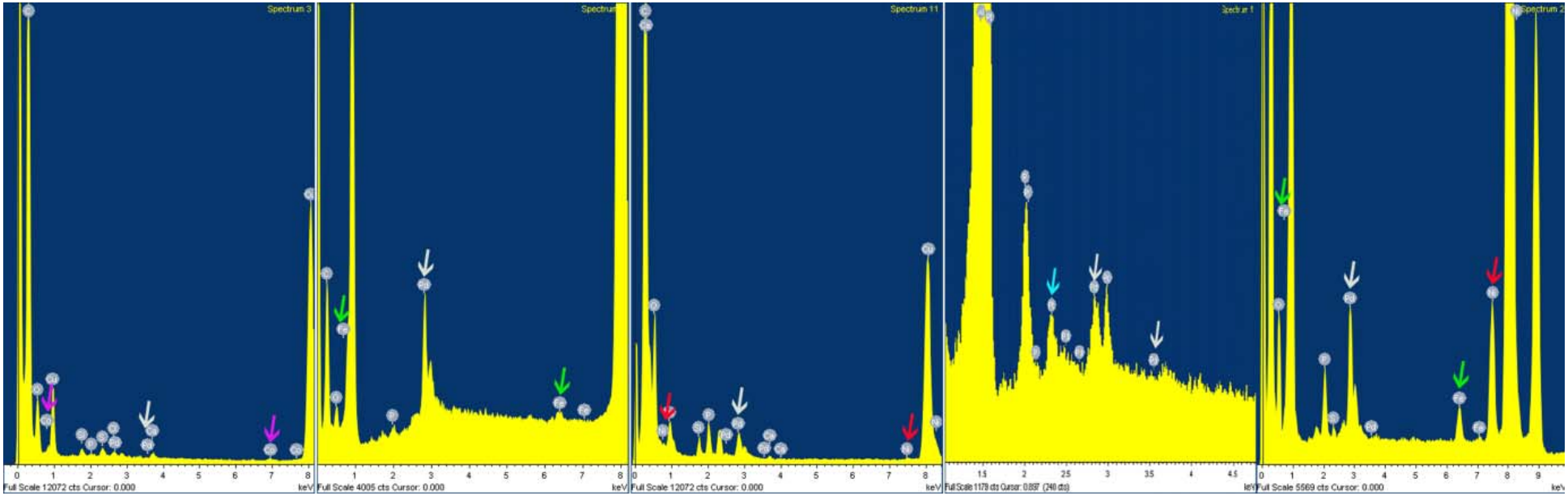

Figure S-5. EDX spectrum of Co-CPMV, Fe-CPMV, Ni-CPMV , Pt-CPMV and NiFe-CPMV metallized particles. Major metal peaks indicated by arrows.

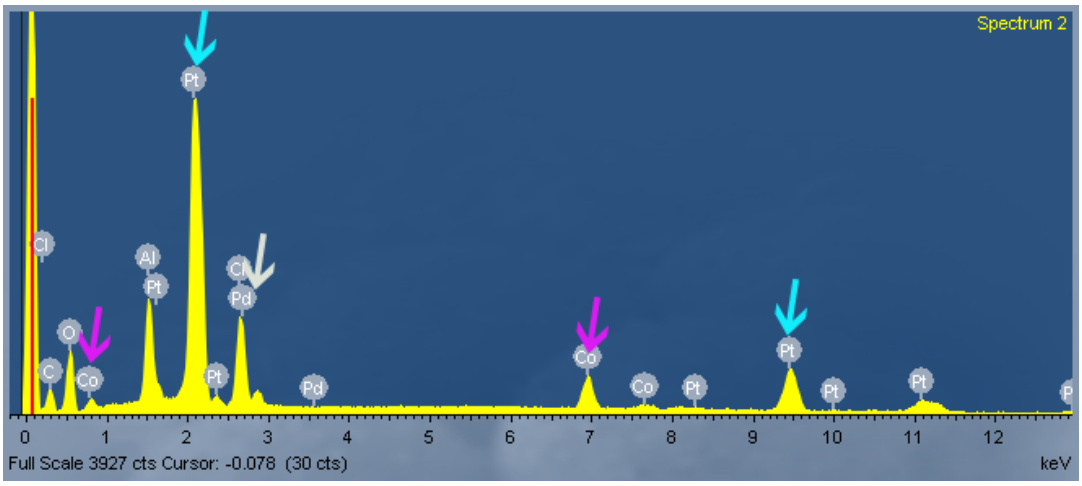

Figure S-6. EDX spectrum of CoPt-CPMV metallized particles. Major metal peaks indicated by arrow.

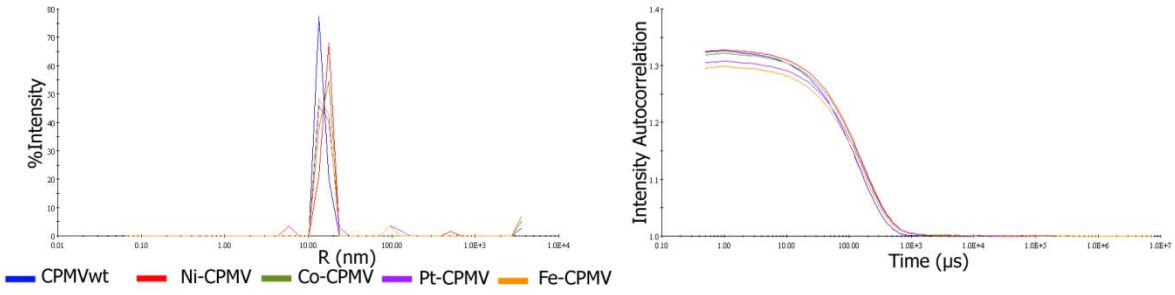

Figure S-7. DLS comparing wild-type CPMV to Ni-CPMV, Co-CPMV, Pt-CPMV, and Fe-CPMV particles. Hydrodynamic radius plot (left) and correlation graph (right).

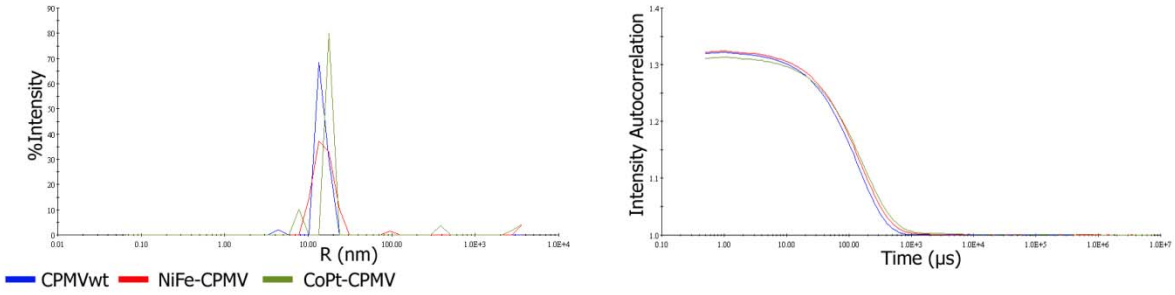

Figure S-8. DLS for wild-type CPMV, NiFe-CPMV and CoPt-CPMV particles. Hydrodynamic radius plot (left) and correlation graph (right).

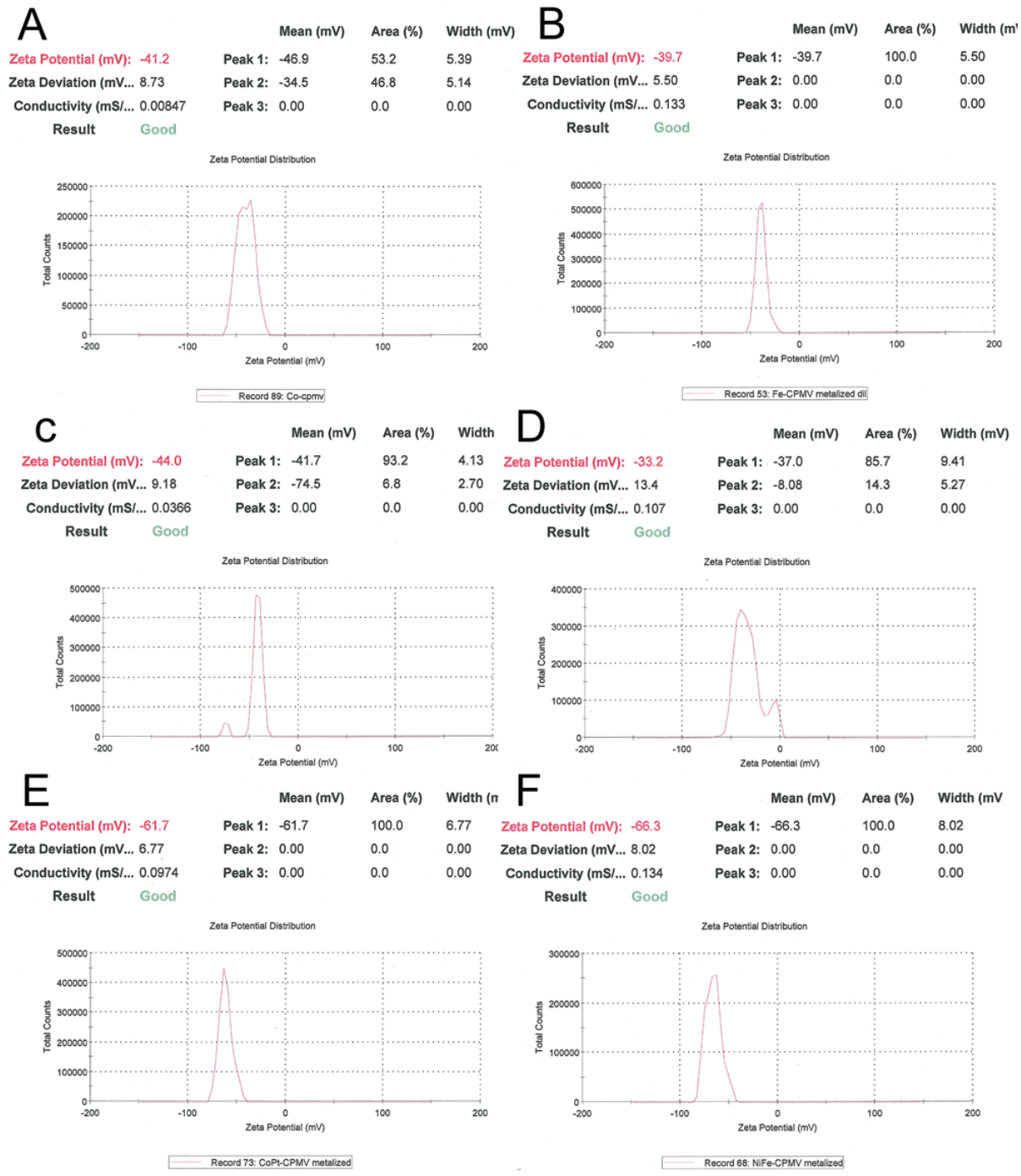

Figure S-9. Zeta potential measurement of (A) Co-CPMV, (B) Fe-CPMV, (C) Ni-CPMV, (D) Pt-CPMV, (E) CoPt-CPMV and (F) NiFe-CPMV particles suspended in buffer at pH 7.0.

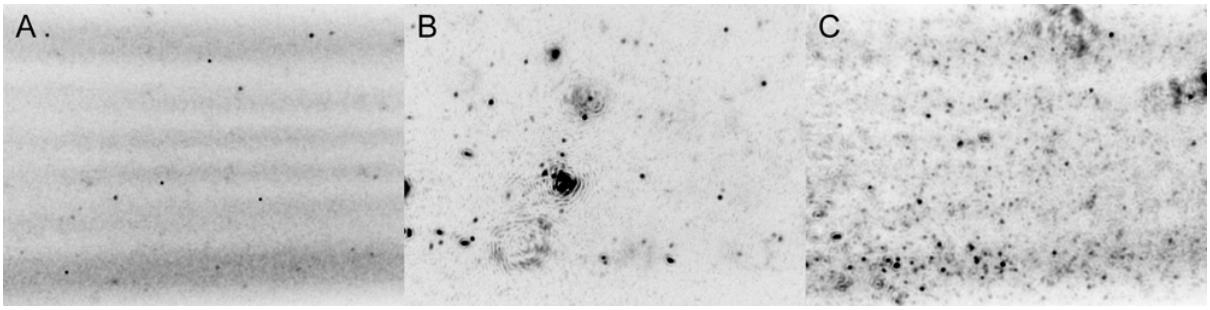

Figure S-10. Negative image of a freeze-frame from nanoparticle tracking analysis for metallized-CPMV nanoparticles showing that the particles appear individually as point scatterers under Brownian motion with a high refractive index. (A) Co-CPMV; (B) Ni-CPMV; (C) CoPt-CPMV.

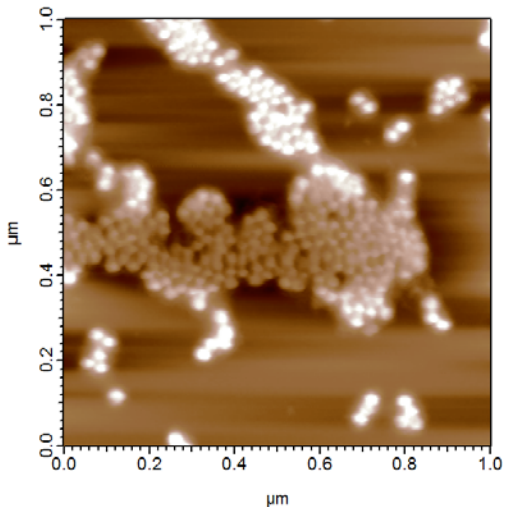

Figure S-11. AFM image for Ni-CPMV dried on glass slide.