Electronic Supplementary Information for

Direct observation of liquid-like behavior of a single Au grain boundary.

Gilberto Casillas, Arturo Ponce, J. Jesús Velázquez-Salazar and Miguel Jose-Yacaman

Department of Physics and Astronomy, University of Texas at San Antonio,

One UTSA Circle, San Antonio, Texas 78249, USA.

Experimental methods

We used an AFM-TEM holder from Nanofactory Instruments AB to perform the *in situ* experiments. The NPs were synthesized by a seed-mediated growth method.[1] The seeds were prepared by an aqueous mixture solution composed of 0.125 mL of 0.01 M HAuCl4 and 3.75 mL of 0.1 M CTAB, then immediately added 0.3 mL of 0.01 M NaBH4 solution, followed by rapid inversion mixing for 2 min. The resulting seed solution was kept at room temperature for 2 h before use. The seed solution was diluted 50 times with DI water. For final growth the solution was prepared by the sequential addition of 6.4 mL of 0.1 M CTAB, 0.8 mL of 0.01M HAuCl4 and 3.8 mL of 0.1 M ascorbic acid into water (32 mL). 200 μL of seed solution diluted was added to the growth solution immediately.

The NPs were drop-casted onto the tip of a 0.25 mm gold wire of 1 cm in length, which was then mounted on to a brass cap, to finally mount it in the AFM-TEM holder, as shown in Fig. S3. Once inside the TEM, the gold wire was manipulated through the Nanofactory software. The experiments were performed in a JEOL JEM-2010F equipped with a field emission gun and a Fast-Scan ATM CCD. Videos were recorded with an exposure time of 0.1 s per frame, and are displayed at a 15 frames/second rate.

The experiments consisted in applying a load to a NP with the Si tip, until it adhered to the tip. Once a good adhesion was obtained, a different NP was approached to the Si tip and brought to contact with the fixed NP. After cold-welding the NPs, the behavior of the GB was recorded in the CCD for analysis.

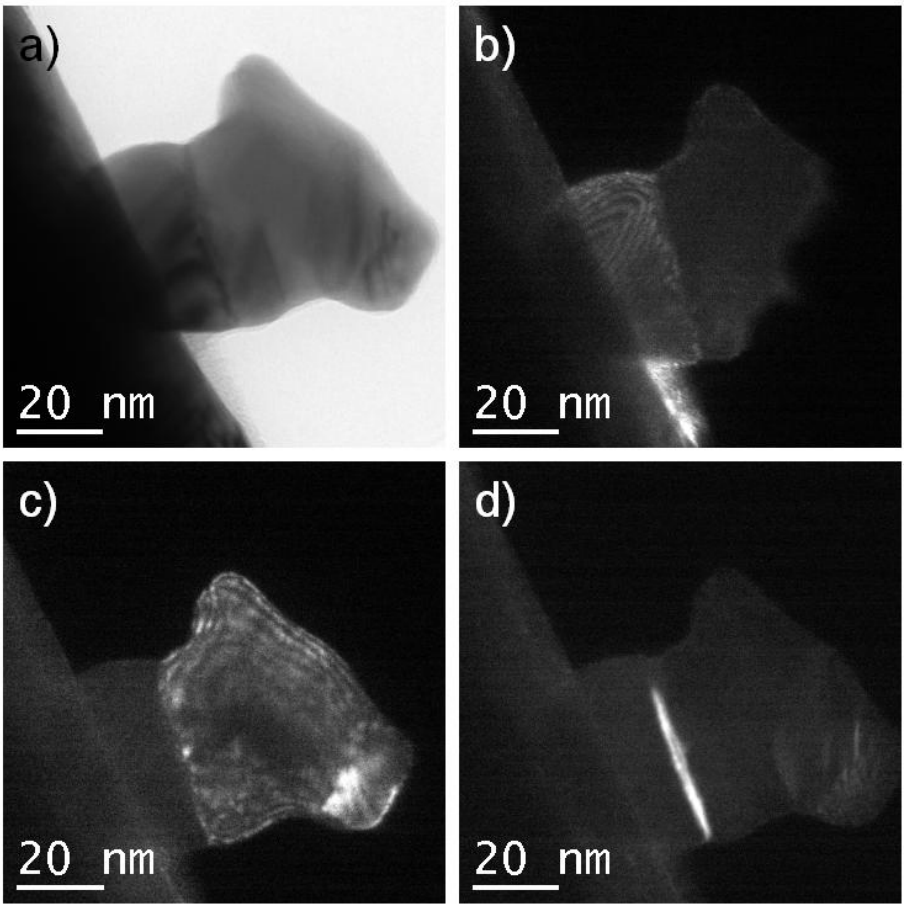

Fig. S1. (a) BF TEM image of the NPs in Fig. 1-3 after the top one detached from the silicon tip. (b) DF image of the left particle. (c) DF image of the right particle. (d) DF image of the GB.

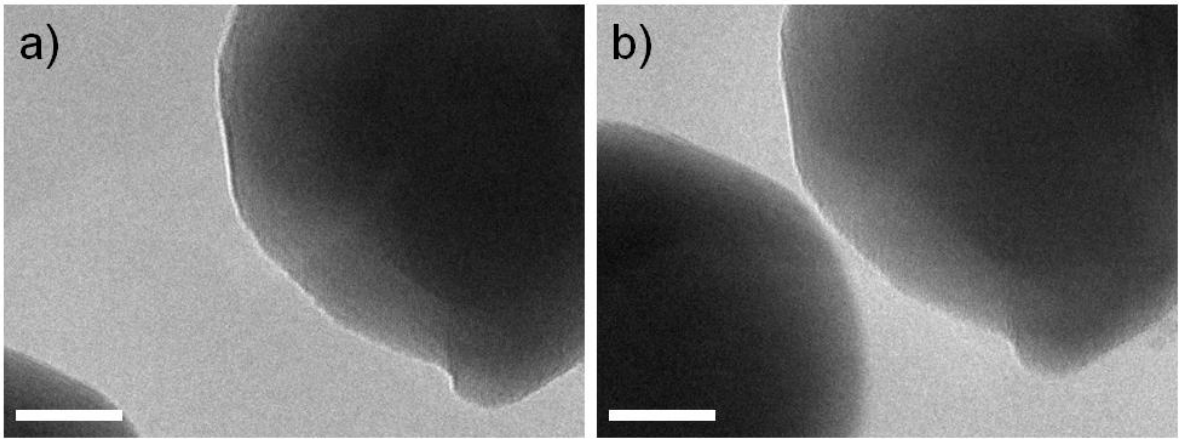

Fig.S2. TEM images of the NPs in Fig. 4 before contact. (a) Shows a frame at a time of 1 s of supplementary video 4, while (b) shows a frame at 41 s. The morphology of the NP on the right stays the same during the whole process confirming that the electron beam had no effects on the behavior of the GB. Scale bar is 10 nm.

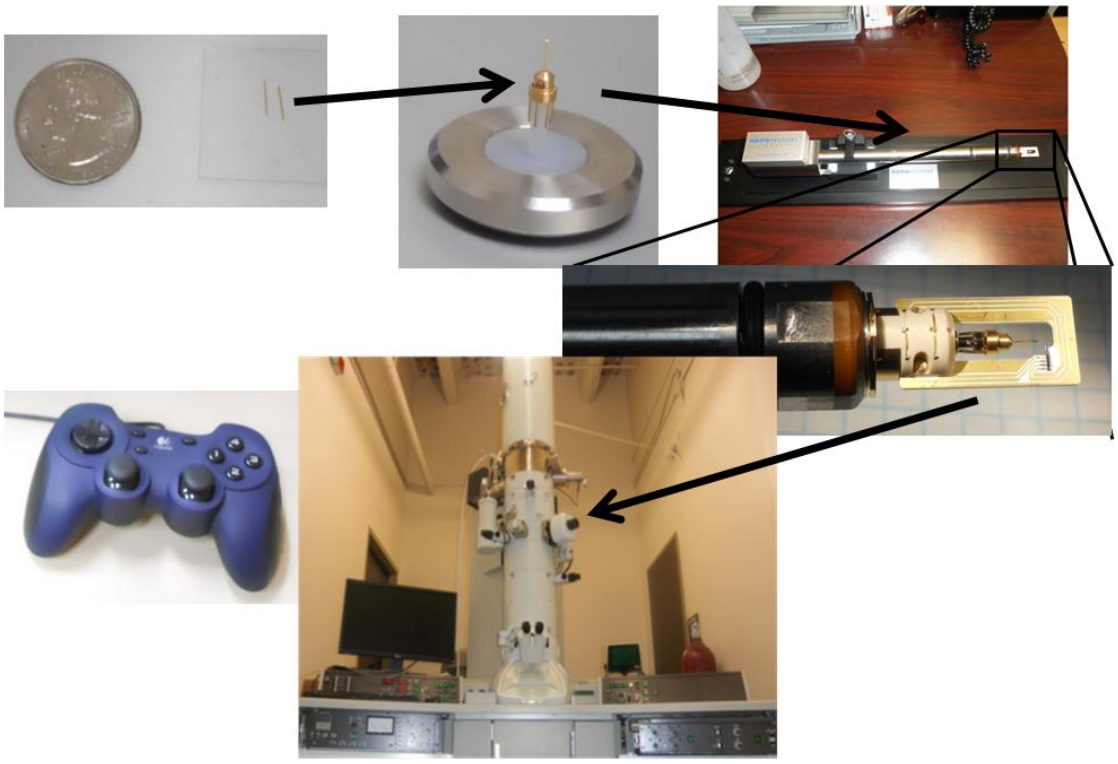

Fig. S3. Schematic of the experimental set-up.

Supplementary Video 1. TEM video of the sequences shown in Fig. 1, 2 and 3.

Supplementary Video 2. TEM video of the sequence shown in Fig. 4.

Supplementary Video 3. TEM video of the loading process of two welded NPs.

Supplementary Video 4. TEM video of the NPs in Fig. 4 before contact.

References

1 T. K. Sau, C. J. Murphy, *J. Am. Chem. Soc.*, 2004, ***126,*** 8648.

grain boundary.