Defects in gold nanoplates: A full characterization using PED

Mendoza-Ramirez, M.[1] and Avalos-Borja, M.[1]

[1] Instituto Potosino de Investigacion Cientifica y Tecnologica, Mexico

It is well-known that the physical and chemical properties of nanoscale crystals are closely related to the nanoparticle shape and size. For this reason, shape and size control during the nanoparticles synthesis has become on a priority on materials research.

Even when hard work has been done optimizing synthesis procedures, crystal growing mechanisms remain not fully described. Some authors have suggested that crystalline defects play a very important role on crystal growth[1]. Nevertheless this role is mostly unknown.

In our research, Au nanoplates like those shown on Figure 1 (c, d, e), were synthetized following Kan[2] methodology, using binary surfactants. Their further characterization was achieved in a Tecnai-F30 TEM operated at 300 kV. The novel Precession Electron Diffraction (PED) technique[3], was used for elucidating the structural characteristic of the so-called 1/3 (422) "forbidden reflections" (FR) commonly found by SAED in this kind of particles.

For nanoplates, reactants were acquired from Sigma Aldrich and are listed below: Cetyltrimethylammonium bromide (CTAB, ≥ 99%), polyvinylpyrrolidone (PVP, K-30, Mw = 40 000), ethylene glycol (EG) and hydrogen tetrachloroaurate tetrahydrate ($HAuCl_4 \bullet 4H_2O$).

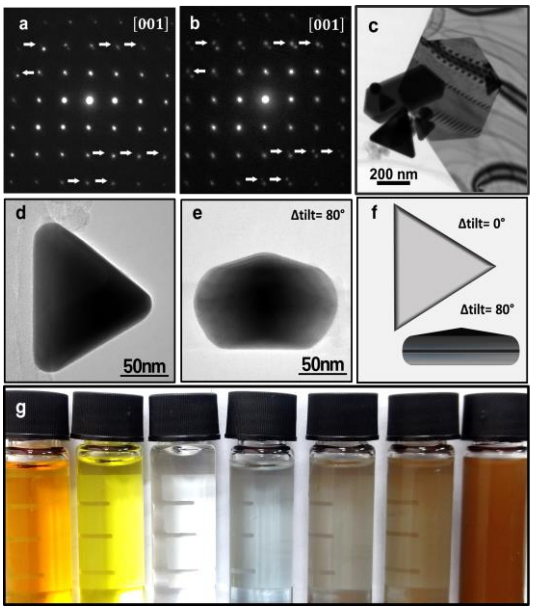

Figure 1. (a) And (b) two [001] patterns comparison SAED and PED respectively, (c) Nanoplates showing bending contour contrast. On (d) and (e) a typical tilting

experiment, (f) A diagram of (d) and (e). (g) Typical synthesis products from the seed solution (left) until nanoparticles solution (right).

For diffraction experiments isolated and clean crystals were selected, like the one shown on Figure 1(d). A multi-zonal axis analysis was done, obtaining pairs of micrographs with ±40° tilting, Figure 1 (d and e). Finally zone axis diffraction patters were acquired using an analogic SpinningStar P-20 PED unit, Figure 1(b). A large precession angle (2.4 degrees) was applied to avoid dynamical diffraction.

Beautiful bending contours were observed during tiling experiments, several zone axis patters will be shown, and the nature of the internal defects will be discussed.

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