

## Copper, palladium and platinum nanostructures with controlled morphologies via polyethyleneimine assisted chemical synthesis

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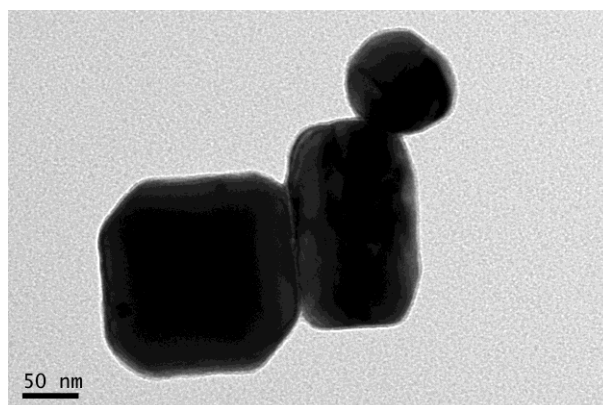
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### Abstract

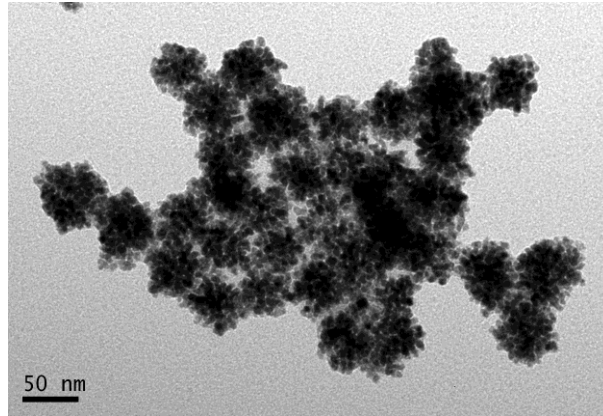
Metals with excellent optical or catalytic properties have drawn important interest for their fabrication in the nanoscale by 'bottom-up' approaches. The small size of the nanoparticles together with a non-isotropic shape can induce certain differences in the acquired material properties in comparison with the 'bulk' ones. However, metals such as Cu, Pd and Pt possess an intrinsic highly symmetric face-centered-cubic (fcc) crystal structure. Therefore, the insertion of shape-directing agents such as proper surfactants is needed to drive the particles growth to an anisotropic mode.

Polyethyleneimine (PEI) is a hydrophilic polymer with primary, secondary and tertiary amino groups and an abundant positive charge. In this work, we present the use of PEI as a stabilizer and shape-modifying agent for the tailored synthesis of water-dispersible Cu, Pd and Pt nanostructures with various morphologies. Typical shapes include for instance copper nanoparticles (Fig. 1), palladium nanodendrites (Fig. 2) and platinum nanoflowers (Fig. 3). The co-reducing role of PEI is also presented, depending also on the rest synthesis parameters used (such as the choice of solvent-reductant and the reaction temperature). We also compare the role of different reaction conditions (type and concentration of solvents, surfactants, reducing agents, precursors as well as temperatures) for the successful preparation of anisotropic shapes for the systems under study. Moreover, we present and discuss the basic physical properties (optical, electrocatalytic) of our nanomaterials.

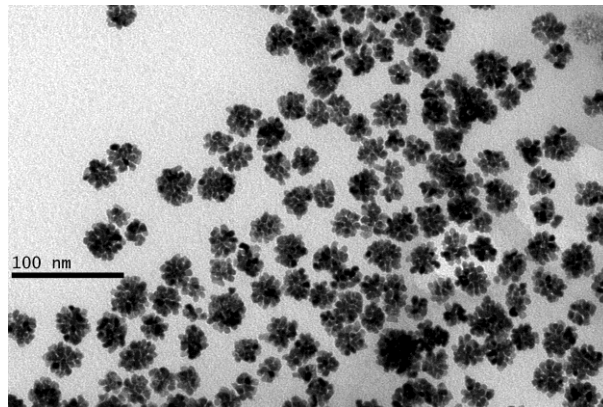
### Figures



**Fig. 1** TEM image of copper nanostructures prepared in the presence of PEI and diethyleneglycol



**Fig. 2** Palladium nanodendrites obtained by reducing  $K_2PdCl_4$  in the presence of oleylamine and polyethyleneimine



**Fig. 3** Flower-like platinum nanostructures synthesized by the thermolytic reduction of platinum acetylacetonate in a DEG/PEI mixture