Expanding the boundaries of cathodic corrosion: The effective preparation of metal alloy nanoparticles and mixed oxides and their use as active electrocatalyst and photocatalyst

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Among the properties of the nanocatalyst, the composition of the alloys is perhaps the most important parameter since the chemical and physical properties of the alloy are correlated with the electronic states. Unfortunately, a large number of metals are immiscible with each other under ambient conditions and in a wide range of temperatures, therefore metallurgical high temperature methods are traditionally needed to prepare bimetallic alloys, involving melting of two bulk metals[1]. Other similar methods including laser ablation[2,3], induction melting and microwave synthesis[4] often use high temperatures greater than 800°C for long periods of time causing an increase of the particle size and reducing the surface area and number of accessible active sites. In addition and more important scaling-up these processes for industrial applications are not straightforward and it will require large investment.

I will describe a single pot and room temperature method for the preparation of solid-solution alloy nanoparticles which the constituent elements are immiscible in the bulk state at room temperature. This novel method takes advantage of the non-equilibrium synthetic conditions of the cathodic corrosion[5,6]. Even more, I will introduce the use of the cathodic corrosion method [1] for the facile synthesis of oxides and metal oxide nano- and microparticles, including TiO_2, $BiVO_4$ and WO_3. This method only requires the input of a metal substrate, and upon the use of a well-defined cathodic waveform generates particles of well-defined composition, crystallinity and shape.

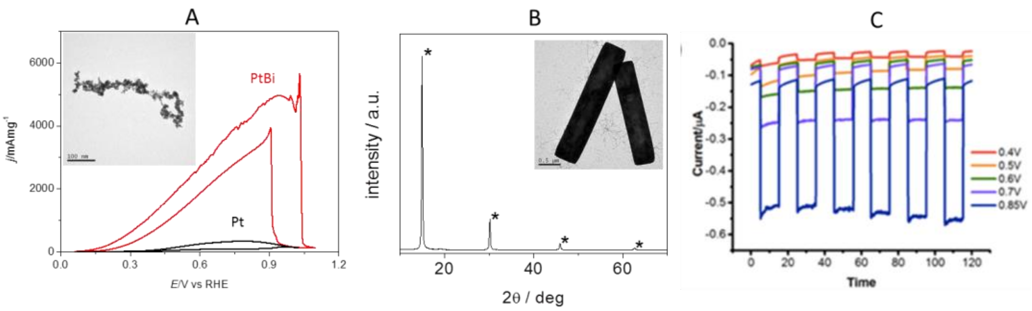

Figure 1. (A) Voltammetric profiles of the $Pt_{70}Bi_{30}$ nanoparticles in 0.5 M H_2SO_4 at υ= 50 mV/s. Inset: TEM image of $Pt_{70}Bi_{30}$ nanoparticles. (B) XRD and TEM images of HWO_4 nanoparticles showing the morphology and crystallinity. (C) Light chopping experiments showing photoanodic water oxidation.

It is important to note the “green” character of this synthetic method since it does not require organic ligands, capping agents, nor high temperatures, therefore the catalytic activity will not be affected by undesirable adsorbed species. Other benefits of the method include the suitability for scale up for industrial applications, avoiding large investments in large volume of organic solvents, heating or cleaning treatment, incurred safety and disposal issues.

References

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