

## OC-32: Ultrasonically Assisted Decoration of Anode Materials for Solid Oxide Fuel Cells

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Solid oxide fuel cells operation under steam or dry reforming conditions relies heavily on the catalytic capabilities of their anode materials. When the anode side is fed with natural gas (NG) the reforming reactions are expected to convert the feeding fuel into hydrogen which will further be utilized, on site, for the fuel cell anodic reaction. The carbon and sulphur contained by default in NG lower the reforming rate. Thus, C and S tolerant anodic materials are important for promoting the reforming reaction. Such materials are obtained by addition of certain metal nanoparticles (M-NPs) such as Au, Ag, Cu and Mo, W, Re, for S and C tolerance respectively (Gong et al. 2007; Gavrielatos et al. 2008).

This work aims at the ultrasonically assisted decoration of state-of-the-art NiO/GDC anode powders (size of  $<1\mu\text{m}$ ) with Au, Mo, W and Re nanoparticles (Fig. 1-4). Sono-electrochemical methods are used for the Au-NP (5-35nm) synthesis whereas Mo, W and Re oxides ( $<100\text{nm}$ ) are synthesized sonochemically. Two approaches were implemented regarding NPs decoration on anode powder. On one hand M- or metal oxides (MO-) NPs were initially synthesized and accordingly co-sonicated with the substrate powder (post synthesis decoration). On the other hand a synchronous co-sonication of precursor and substrate material was investigated (synchronous synthesis decoration). In both cases a well dispersed decoration of 1-3 wt. % was achieved.

For the sono-electrochemical experiments  $\text{HAuCl}_4 \cdot n\text{H}_2\text{O}$  is used as precursor and Polyvinylpyrrolidone (PVP) as stabilizer mixed in an acidic aqueous solution (Aqil et al. 2008). For all sonochemical syntheses metal carbonyls ( $\text{Mo}(\text{CO})_6$ ,  $\text{W}(\text{CO})_6$ , and  $\text{Re}_2(\text{CO})_{10}$ ) are the precursors as they contain the metal atoms already in the zero-valent oxidation state needed for M-NPs. Decahydronaphthalene (Decalin) and Diphenylmethane (DPhM) are suitable organic solvents for the MO-NPs synthesis. In this case no stabilizers are used. In all cases, no extra reducing agent is necessary (Dhas and Gedanken 1997; Koltypin et al. 2002; Vollmer et al. 2010). The intensity selected for scaling Au depositions off the sonotrode is in the order of  $10 \text{ W/cm}^2$  and the one for sonochemical MO-NP synthesis is  $30\text{-}100 \text{ W/cm}^2$ .

Table 2

### Metal and metal oxides nanoparticles synthesis characteristics.

Material	Precursor	Stabilizer	Solvent	Intensity ( $\text{W/cm}^2$ )	Size (nm)
Au	$\text{HAuCl}_4 \cdot n\text{H}_2\text{O}$	PVP	Aq./ $\text{H}_2\text{SO}_4$	10	5-35
Mo oxide	$\text{Mo}(\text{CO})_6$	N/A	Decalin	100	5-20
W oxide	$\text{W}(\text{CO})_6$	N/A	DPhM	100	1-20
Re oxide	$\text{Re}_2(\text{CO})_{10}$	N/A	DPhM	30-60	1-20

Metal particles size distribution is identified by means of Dynamic Light Scattering (DLS) directly on the resulting solution during the experiment evolution (Wang 2007). TEM study of selected samples gives also a clear picture on the morphology and the evolution process of the resulting NPs. Moreover, XRD, SEM (EDX) and FT-IR are used for further characterisation of the materials produced.

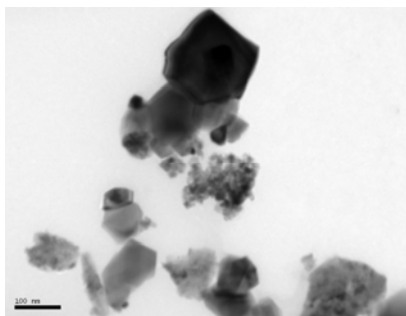


Fig. 1: Au-NP post synthesis decoration

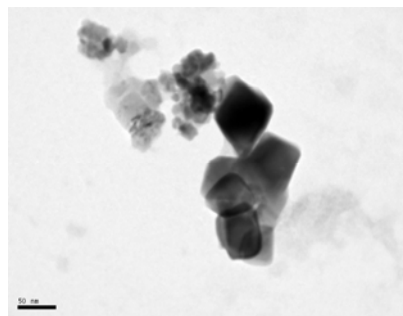


Fig. 2: Mo-NP post synthesis decoration

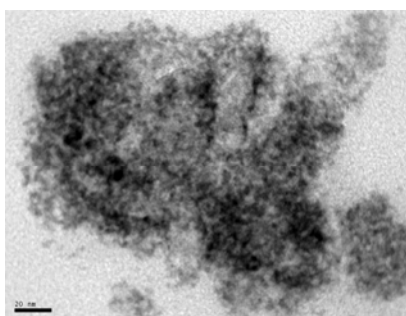


Fig. 3: W-NP (<10nm) sonochemical synthesis

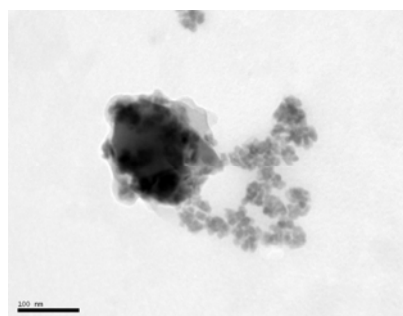


Fig. 4: Re-NP synchronous synthesis decoration on NiO/GDC powder

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