Refinement of nanoporous copper by dealloying MgCuY amorphous alloys in organic and sulfuric acids

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The nanoporous copper could be used as the substrate for the Au-/Pt-decorated catalyst, which contribute to more efficient application of expensive natural resources. On the other hand, the catalytic performances, capacity, and physiochemical properties of these nanoporous materials are dependent on their nanoporosity. Therefore, the ultrafine nanoporous materials are highly anticipated. The present study focused on the fabrication of the nanoporous copper by using selective dissolution of Mg and Y from MgCuY amorphous precursors.

The mixture solution of the organic chemical, poly-vinyl-prrolidone (PVP, ~55000), and 0.1 M H_2SO_4 was used as the dealloying solutions. The surface change and their microstructure of amorphous precursors and dealloyed ribbons were examined by XRD, SEM, TEM and XPS, etc.

The XRD analysis indicated that the MgCuY ribbons were amorphous. The residual phases of dealloyed ribbons were confirmed to be fcc Cu. The nanoporous copper formed in 0.1 M H_2SO_4 solution (Fig. 1a) had a mean pore size of 88 nm. That in 0.1 M H_2SO_4 + 2 g/L PVP had a pore size of 16 nm, 5 time smaller than the former one. With increasing the PVP content, the pore size further decreased down to 10 nm.

The decrease in the pore size mainly resulted from the drastic decrease in the surface diffusivity. The PVP molecular has a large size and the linear PVP molecule served as an artificial diffusion barrier to restrict the fast and long-distance diffusion of Cu adatoms during dealloying the amorphous precursors. The build-up of the artificial diffusion barrier is regarded to be a facile route to refine the nanoporous copper and the expected nanostructures could be obtained by handling the dealloying solutions.

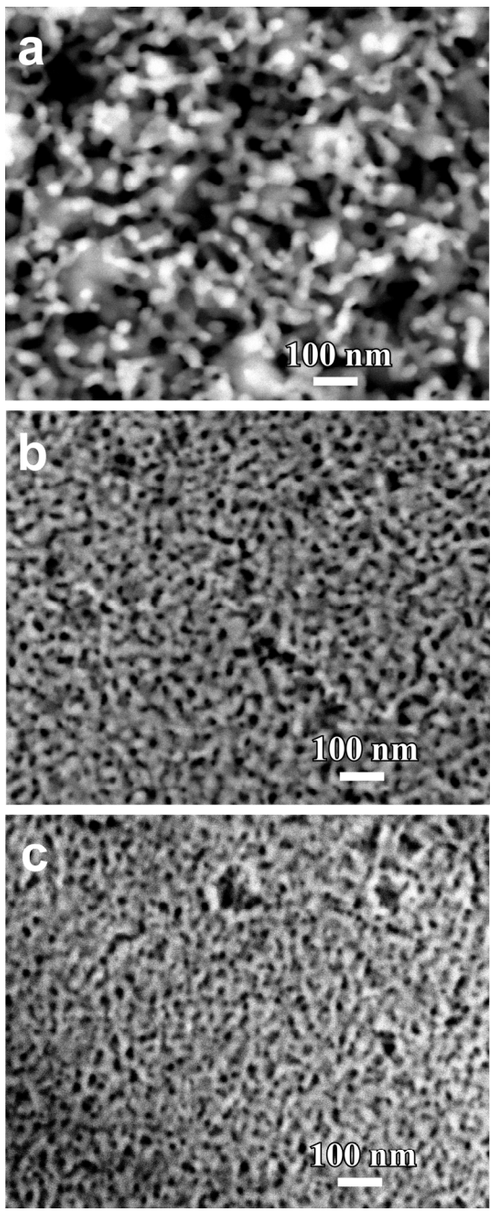

Fig. 1 SEM morphology of MgCuY amorphous alloy after dealloying in 0.1 M H_2SO_4 (a), 0.1 M H_2SO_4 + 2 g/L PVP (b) and 0.1 M H_2SO_4 + 10 g/L PVP solutions for 1800 s.