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Oxidation and dealloying processes of Cu-Au alloy nanoparticles

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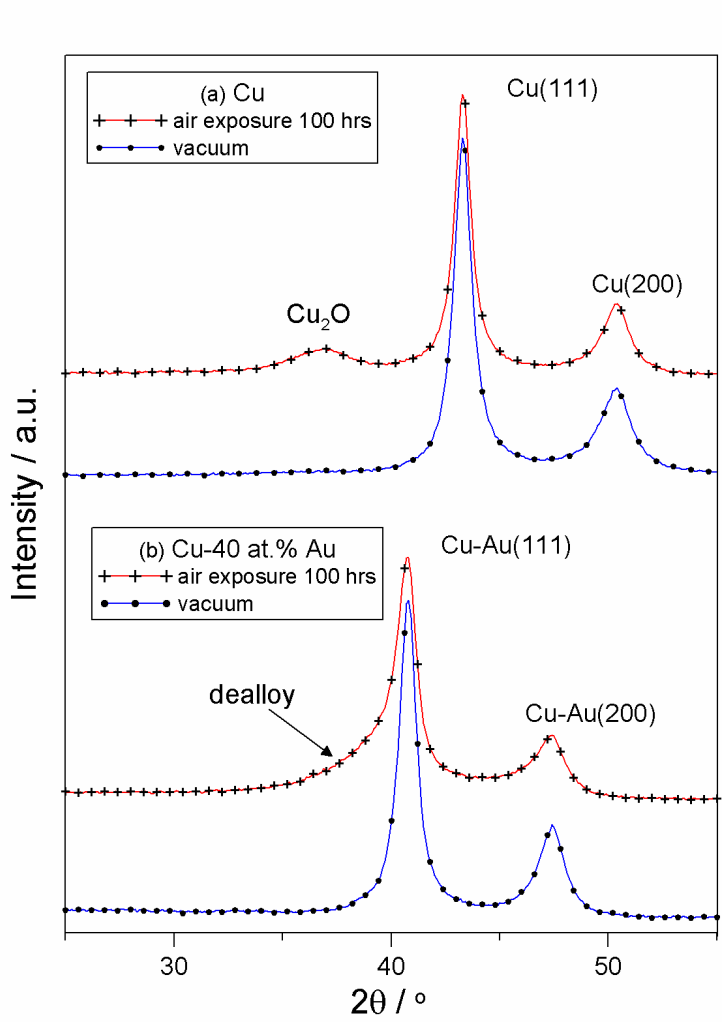
Oxidation of Cu and its alloy nanoparticles is of great importance for both theoretical and practical purposes. Till now very little is known about the oxidation in nanoscale Cu and its alloys although that in bulk cases [1,2] has been investigated for a long time. Further research is therefore needed. In this presentation, we report the quantitative analysis results of the composition and temperature dependent oxidation of Cu-Au alloy nanoparticles.

The Cu-Au alloy nanoparticles (10 and 40 at. % Au; ~17 nm in mean size) were generated by cooling Cu-Au alloyed vapor from a high purity Cu-Au ingot at 1743 K with purified helium in a vacuum chamber. They were transported with a helium flow through a stainless tube, and deposited on an MgO(100) substrate. Oxidation of deposited Cu-Au alloy nanoparticles by exposure of 700 Torr dry air at 298 K and 323 K has been investigated by means of in-situ x-ray diffraction (XRD) and ex-situ x-ray photoelectron spectroscopy (XPS).

Figure 1(b) shows the XRD patterns of Cu-40 at. % Au before and after oxidation. The typical XRD patterns of clean and oxidized Cu nanoparticles are also illustrated in Fig. 1(a). As can be seen in Fig. 1(b), the Au-rich dealloyed phase was formed during the air exposure indicating the selected oxidation of the Cu component as many previous studies. The exposure time dependent oxidation and dealloying processes were recorded from the variation of the overlapped diffraction peaks of the oxide and dealloy phases. According to the kinetics analysis, a protective oxidation behavior appeared in the specimen of 10 % Au, whereas a non-protective oxidation showed in that of 40 % Au. The ex-situ XPS analysis for the oxidized particles showed the existence of Cu_2O and $Cu(OH)_2$ phases in the specimen of 10

% Au. Nevertheless, CuO and $Cu(OH)_2$ phases are the main oxides in the specimen of 40 % Au. The oxide species and their relative amount showed less change with the temperature increase from 298 to 323 K.



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[2] Badr G. Ateya, James D. Fritz, Howard W. Pickering, J. Electrochem. Soc. 144, 2606 (1997).