Materials Science

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Magnetization and Magnetic Circular Soft x-ray Dichroism of Electrodeposited Nickel Covered with Gold

Koh-ichi MARUYAMA[1], Etsuo ARAKAWA[2], Ko-ichi HIRAKI[3], Hirokazu WATANABE[1], Hitoshi YAMAGUCHI[4], Hiroo NUMATA[5], Toshihiko YOKOYAMA[1], Akiyuki MATSUSHITA[4], Koichi Mori[6], Tsuneharu KOIDE[7], Kazumichi NAMIKAWA[2], Osamu NITTONO[8]
[1]IMS, Okazaki, Aichi 444-8585, Japan, [2]Tokyo-Gakugei Univ., Koganei, Tokyo 186-8501, Japan, [3]Universite Joseph Fourier Grenoble I, Saint-Martin d'Heres, France, [4]NIMS, Tsukuba, Iraraki 305-0047, Japan, [5]TIT, Meguro, Tokyo 152-8522, Japan, [6]IPU, Inashiki, Ibaraki 300-0394, Japan, [7]KEK-PF, Tsukuba, Ibaraki 305-0801, Japan, [8]Fukushima Univ., Fukushima, Fukushima 960-1296, Japan

We have studied nanostructure and its magnetic properties of the electrodeposited(ED) transition-metal . It is interesting that the properties link to the electrochemical behaviour due to the "electrolytic catalysis" at the initial stage of electrodeposition. We found the abnormal increase of magnetization for the nickel film electrodeposited on carbon substrate. The magnetization was measured by SQUID, and however it might be difficult to separate strictly the components of the film and the substrate. On the other hands, MCXD is a very useful probe only for the film magnetization, because of the element-resolved detection. In addition, it is very sensitive to the surface oxide layer. We reported that XAS of ED nickel film was separated into those of nickel and nickel oxide. The ratio of their parts could be calculated, and lead to the meaningful MCXD intensity, spin- and orbital- magnetic moments. However it was difficult to determine the MCXD for the deposits thinner than 3 monolayer(ML) in this manner. We have challenged magnetization detection for the thinner deposits covered with gold by the electroless deposition.

Figure 1 shows magnetization versus deposit thickness for gold-coated and bare nickel. Magnetization saturated in the field more than 4 tesla. Error bars of data points denote the obscured ranges due to the magnetic components of substrate. The magnetization of gold-coated nickel deposits increased with a decrease in the thickness less than 5ML, and reached to twentieth times as large as that of the bulk nickel. The bare nickel exhibited similarly to these deposits, except for 0.5ML deposit, which may be the magnetization reduction due to the surface oxidation in air after the electrodeposition.

Figure 2 shows XAS and MCXD of Ni $L_{3,2}$ edge for several gold-coated ED nickel(30nm) deposits and the electron-beam evaporated (BE) gold(2nm)/nickel(15nm) films on amorphous carbon, used as a reference of pure nickel. For Au 1nm sample, the intensity of L_3 peak significantly increased, and that of the region between L_3 and L_2, and the energy region higher than L_2 edge was decreased, which is the similar to XAS of the surface oxidation of bare nickel deposits, and the reduction of MCXD obtained due to the antiferromagnetic order of nickel element. For Au 5nm sample, only the enhanced increase of L_3 peak appeared, which may be the change in the electron hole due to the alloy formation, Au-Ni. Non-

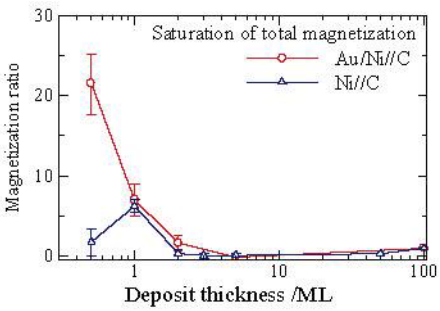

Fig.1 Magnetization of gold-coated and bare ED nickel on carbon substrate. Ferromagnetic component saturates within about 1 tesla field, and super paramagnetic components, 4 tesla. The total magnetization means the addition of both components.

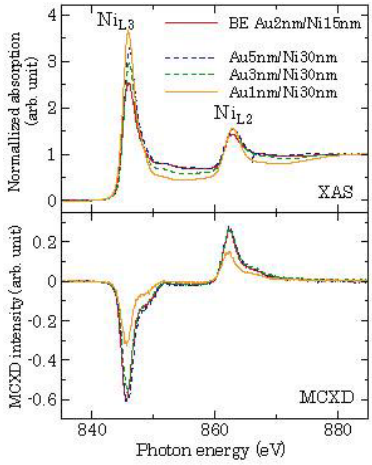

Fig. 2 XAS and MCXD of the gold-coated ED and BE nickel films. BE one is a reference as non-oxide nickel. XAS contains Ni, Ni-oxide, and Ni-Au phases for ED samples.

reduction of MCXD intensity of this sample is explained by the ferromagnetic order of Ni element in alloy. However it was difficult to determine the ratio of the surface oxidation, for Au 3nm sample, and for the thinner nickel deposits covered with gold, in spite of the simple coating technique.

We are trying to prepare the sample by the other techniques of gold coating, and to detect the MCXD of the thinner nickel deposits.

* maruko@ims.ac.jp