Synthesis of Nano-crystalline Nickel by solvothermal Reduction Process

Yuanzhu Mi, Dingsheng Yuan, Yingliang Liu*
Jingxian Zhang
Tel: +862085221813; Fax: +862085221697; E-mail: liuyi@jnu.edu.cn
Department of Chemistry, Jinan University, Guangzhou 510632, P.R. China

Transition metallic materials such as ferro-magnetic metal Ni, Fe, Co have been extensively studied because of their various applications, such as catalysis, solar energy absorption, permanent magnets, magnetic fluids and magnetic recording media. Nickel nano-structures have thus attracted much attention recently because of their potential applications in magnetic sensors and memory devices [1-3]. Different Ni nanostructure have been successfully synthesized by various methods.

Herein we report the preparation of fcc and hcp phase nickel through reduction of nickel chloride by KBH4 in the absolute enthylene diamine. Their magnetic properties have been measured.

Fig. 1 is the XRD pattern for the as-prepared Ni sample synthesized in enthylene diamine at different temperature. Figure 1a is shown x-ray diffraction pattern of Ni at 300°C. The peaks are assigned to from the (010), (002), (011), (012), (110), (103), (112), (201) planes of hexagonal close-packed (hcp) nickel, respectively. Which are in agreement with the value in the JCPDS card (No45-1027). From the pattern, no characteristic peaks presenting face centered cubic (fcc) nickel have been observed. Fig.1b is the XRD pattern for the sample at 250°C. The peaks from the pattern can be indexed to hcp and fcc nickel, which indicates that both hcp and fcc phases of nickel coexist in the samples at 250°C. The nickel synthesized at 200°C is only fcc phase (as shown in Fig.1c).

Figure 2 is shown the transmission electron microscopy (TEM) images of Ni synthesized in enthylene diamine at 300°C. Figure 2A is a high-resolution electron microscopy (HREM) image. Microstructure of nickel shows hexagonal. Figure 2B shows a typical selected-area electron diffraction (SAED) pattern that has recorded from the nanocrystal Ni. It can be indexed to be the (011) zone axis of the hcp nickel. These pattern spots demonstrate the single crystallinity of this Ni nanocrystals.

The magnetic properties of nano-sized Ni have been measured through VSM 7407 magnetometer. Figure 3 shows hysteresis loops of different crystal phase Ni at room temperature. The saturation magnetization (Ms) and coercivity (Hc) of fcc Ni are 39.86emu/g and 143.93Oe, respectively. These of hcp Ni are 7.35emu/g and 94.32Oe, respectively. Thus, nano-sized Ni materials with the different structure possess the different magnetic properties.


Fig 1 XRD pattern of Ni synthesized in enthylene diamine at different temperature. (a)200°C,(b)250°C,(c)300°C. (*hcp phase nickel, fcc phase nickel. Peaks represent fcc phase nickel (marked in parentheses)

Fig 2 TEM images and the electron diffraction pattern of nickel nanocrystals synthesized at 300°C

Fig 3 Hysteresis loops of different crystal phase Ni at room temperature. (A)fcc, (B)fcc and hcp, (C)hcp