Low temperature synthesis of Fe and Fe-based alloys

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The synthesis of Fe and its alloys through aqueous chemical methods has been found to be difficult due to the highly oxidizing nature of Fe. Some of the chemical methods like thermal decomposition of pentacarbonyl iron is environmentally unfriendly. Although the synthesis of Fe is reported in polyols, the reaction mechanism is not clear so far. Moreover, the synthesis of nanoparticles of Fe has not been reported in polyols. The understanding of the reaction mechanism on the synthesis of Fe in polyols can thus be used to synthesis potential high coercivity magnetic materials like FePt, which is used for recording applications. We present here, the synthesis of Fe and FePt nanoparticles in polyols at low temperatures.

The synthesis of Fe was attempted in various polyols like ethylene glycol, tetramethylene glycol (TMEG) and propylene glycol. In a typical experiment, $FeCl_2.4H_2O$ and NaOH are added to the polyol and heated at around 120 ^oC. Depending on the polyol, molar concentration and temperature, the formation of Fe nanoparticles and oxide peak occurs. The formation of oxide peak is due to the smaller particle size of the Fe which undergoes oxidation. The synthesis of Fe nanoparticles in polyols has paved way in the successful synthesis of FePt nanoparticles at temperatures as low as 80 ^oC. The oxide peak is not observed in the FePt nanoparticles due to their stable nature compared to Fe. The composition of the FePt nanoparticles could be controlled to $Fe_{50}Pt_{50}$ as found from the composition analysis using a transmission electron microscope (TEM), for the particles synthesized at 200 ^oC in TMEG. The x-ray diffraction (XRD) pattern of the FePt nanoparticles synthesized in TMEG at various temperatures are shown in Fig.1. At all the temperatures, the particles showed FePt peaks with the Fe content increasing with temperature as found from the composition analysis. The particle size of the FePt nanoparticles is around 2-3 nm as shown in the TEM picture (Fig.2). The small particle size is responsible for the superparamagnetic behaviour of the FePt nanoparticles showing very low coercivity. The present studies suggest that polyol process can be effectively used in the synthesis of Fe and its alloy nanoparticles.

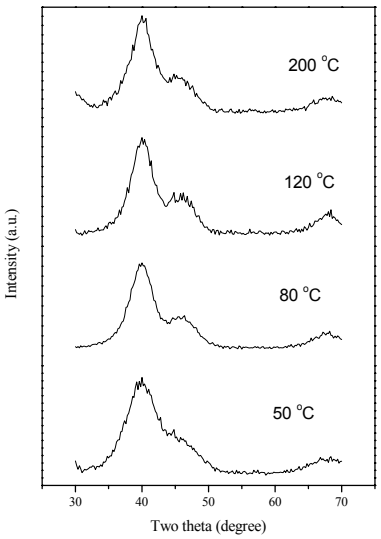

Fig.1. XRD of the FePt nanoparticles synthesized in TMEG at various temperatures.

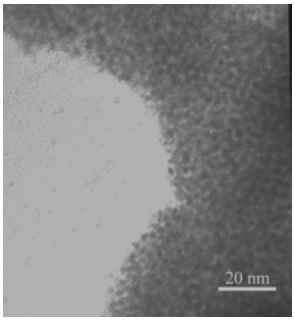

Fig. 2. Typical TEM micrograph of the FePt nanoparticles synthesized in TMEG.