Synthesis of multilayer graphene encapsulated iron nanoparticles using chemical vapor deposition from Fe-sulphate based precursors

Sıddıka Mertdinç
M. Lütfi Öveçoğlu, Duygu Ağaoğulları
Istanbul Technical University, Chemical and Metallurgical Engineering Faculty, Metallurgical and Materials Engineering Department, Graphene and 2D Materials Laboratories, 34469, Istanbul, Turkey.
mertdinc@itu.edu.tr

Abstract

Magnetic nanoparticles have been developed for various biomedical applications such as drug or gene delivery, hyperthermia, diseases' detections and imaging [1,2]. Carbon based encapsulations on magnetic nanoparticles improve the biocompatibility and stability, reduce the agglomerations and provide surfaces for drug carrying [3]. Therefore, solvothermal method, sol-gel method, combustion synthesis, plasma and chemical vapor deposition (CVD) are some of methods that used for obtaining graphene coated nanoparticles [2,4]. In the presented study, multilayer graphene encapsulated iron nanoparticles were synthesized via CVD starting from iron sulphate based precursors. Precursor powders prepared from iron sulphate salts that were mixed with fumed silica in ethanol and heated until the ethanol was vaporized. Then, iron sulphate loaded silica powders were placed into CVD system and heated to different temperatures (900, 950 and 1000°C) under 100 ml/min hydrogen (H_2) gas and 100 ml/min methane (CH_4) gas flows. After that, 2 M HF and 3 M HCl solutions were used for leaching to attain purified powders. Remained fumed silica powders were removed with HF acid leaching and uncoated Fe nanoparticles were removed with HCl acid leaching. Synthesized and purified powders were characterized using an X-Ray diffractometer (XRD), Raman spectrometer, scanning electron microscope (SEM), transmission electron microscope (TEM) and vibrating sample magnetometer (VSM) for optimization of synthesized parameters. Representative Raman and VSM results were presented in Figure 1a and 1b prove that nanoparticles with 253.90 Oe coercivity and 91.14 emu/g magnetic saturation have multilayer graphene.

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FIGURES

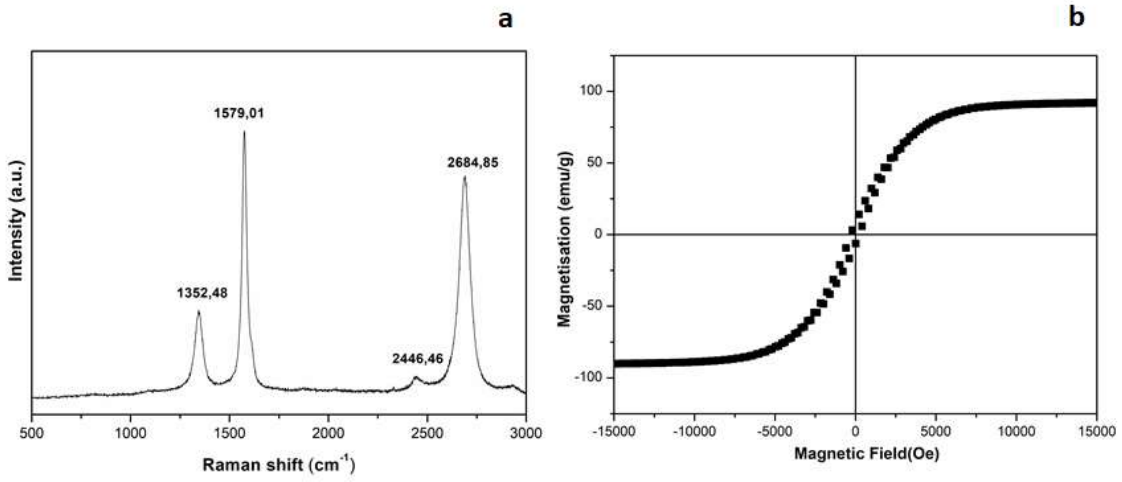

Figure 1: a) Raman shift and b) VSM result of synthesized powders.