課題番号 :F-17-NU-0089
利用形態 :機器利用
利用課題名(日本語) :
Program Title (English) :Fabrication and Characterization Au & Cr thin film, Magnetic Nanostructures
利用者名(日本語) :
Username (English) :E. Suharyadi
所属名(日本語) :
Affiliation (English) :Department of Physics, Gadjah Mada University, Indonesia
キーワード／Keyword : Thin film, Magnetic Nanoparticles, Au, Cr, 形状・形態観察, 分析, 成膜・膜堆積

1. 概要 (Summary):

The optical properties of gold (Au) and Chromium (Cr) thin film have been studied by spectroscopic ellipsometry technique. The measurement of the optical constants used rotating analyzer ellipsometer (RAE) with the visible light source (380 nm to 800 nm). This ellipsometric measurement was performed at different incident angles (60°, 65°, 70° and 75°). The results show the optical constant of the Au thin film does not depend on the incident angle due to the sample is isotropic.

The magnetic nanoparticles $Mn_{1-x}Zn_xFe_2O_4$ ferrite nanoparticles have been successfully synthesized via coprecipitation method under reaction temperature of 120°C. Spinel ferrites are very promising magnetic materials because of their unique physical and chemical properties i.e., crystal structure, narrow band gap, high magnetic and electrical properties, high thermal and chemical stability. $MnFe_2O_4$ and $ZnFe_2O_4$ are the two highly stable and magnetically recoverable spinel ferrite nanoparticles which have low band gap i.e., 1.25 eV and 1.30 eV, respectively. $MnFe_2O_4$ has a partially inverse spinel structure with 80% Mn^{2+} occupying tetrahedral sites and 20% Mn^{2+} in octahedral sites, whereas $ZnFe_2O_4$ has normal spinel structure with all Zn^{2+} occupying tetrahedral sites and Fe^{3+} occupying octahedral sites. For practical application, particle size, crystalline phase, crystallinity, morphology, and other microstructural parameters have very-strong effect on optical band gap, magnetic and photocatalytic properties of nanoparticles

2. 実験 (Experimental)

【利用した主な装置】 原子間力顕微鏡、8 元マグネトロンスパッタ装置、3 元マグネトロンスパッタ装置、磁気特性評価システム群

【実験方法】

The Au and Cr thin films were fabricated by RF Magnetron Sputtering technique on glass slide substrate with the thicknesses of 30 nm, 50 nm and 70 nm using Argon gas pressure of 30 mTorr. Their surface structures were analyzed by atomic force microscopy (AFM). The thickness was determined directly at fabrication by adjusting the sputtering time of Au on the glass slide substrate. $Mn_{0.5}Zn_{0.5}Fe_2O_4$ nanoparticles were prepared by chemical coprecipitation method. The materials used were $FeCl_3.6H_2O$, $ZnSO_4.7H_2O$, $MnCl_2.H_2O$, HCl and NaOH. The morphology and selected area diffraction pattern were characterized by TEM. The room temperature magnetic properties measurement of sample nanoparticles was carried out by using VSM.

3. 結果と考察 (Results and Discussion)

AFM results in Fig. 1 with the scan size of 500 nm × 500 nm on show there are surface roughnesses whose the heights are less than 1 nm (<1 nm) but larger than the size of the atom (> 1Å or > 0.1 nm). The roughness heights of Au with the thicknesses of 50 nm and 70 nm are 0.355 nm and 0.341 nm. Such roughness may affect the calculation of optical constants of the Au thin film.

Although the encapsulation with SiO2 layer has been carried out, the sample of nanocomposites still exhibited agglomeration. Hence, the specific layer of SiO2 on the surface of bare nanoparticles definitely difficult to be investigated of its size.

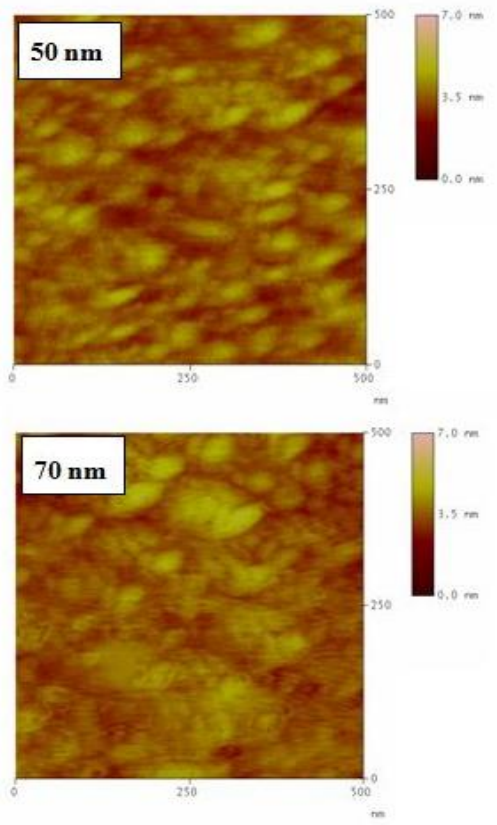

Fig. 1 The surfaces of Au thin films with the thicknesses of 50 nm (a) and 70 nm (b) resulted by by AFM characterization (the scan size of 500 nm × 500 nm)

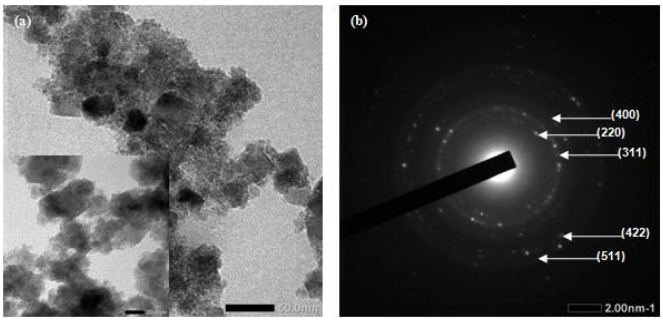

Fig. 2. (a) TEM images of Mn0.5Zn0.5Fe2O4 nanoparticles; (b) SAED image.

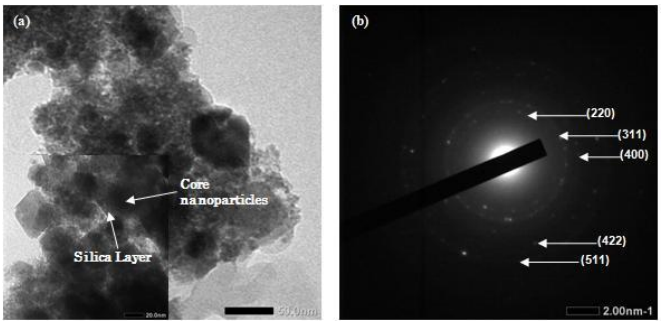

Fig. 3. (a) TEM images of Mn0.5Zn0.5Fe2O4/SiO2 nanocomposites; (b) SAED image.

4. その他・特記事項(Others)

・関連文献

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2. A. Herawati, R.A.N. Khasanah, L.Z. Maulana, E.A. Suyono, E. Suharyadi, I. Santoso ,T. Kato and S. Iwata, **"Microalgae Sensing Using Spectroscopic Ellipsometry Combined with Chromium Films"**, International Conference on Optics & Photonics 2017, Taiwan, 7-9 December 2017.

5. 論文・学会発表 (Publication/Presentation):

None

6. 関連特許(Patent)

None