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キーワード／Keyword : Thin film, Ferrites Nanoparticles, Au, Cr, 成膜・膜堆積

1. 概要 (Summary):

Monitoring microalgae growth has been successfully measured using spectroscopic ellipsometry-based biosensor on the surface of Au and Cr thin film. Spectroscopic ellipsometry-based biosensor has been designed using Rotating Analyzer Ellipsometry (RAE) configuration [1] with the UV-visible light source (200 nm – 850 nm) and was set at 70° incident angle. Gold and chromium thin film with the thicknesses was 50 nm, used as a substrate for microalgae deposition. These thin films were fabricated by RF magnetron sputtering technique and their surface structures have been studied by atomic force microscopy (AFM). Microalgae 0.1 ml (2% concentration) mixed with PVA 0.49 ml (as immobilization agent) were coated on the surface of Au and Cr thin film. The optical model of this sample consists of layers that were denoted by air/Au/PVA/Microalgae and air/Cr/PVA/Microalgae. The monitoring of the growth of the microalgae was performed since day-0 until day-10 for every two days by measuring the ψ and Δ [1]. The change of Δ indicates the growth of microalgae. The Δ shifted of 75° for Cr thin film to 108° for Cr/PVA at 2.5 eV as well as the increase of Δ of Cr/PVA/microalgae to the Cr thin film. This phenomenon indicating that during growth, the cell population and the absorbance changed. An increased population will cause an increased of Δ as well and vice versa.

The magnetic nanoparticles Cobalt doped zinc ferrite magnetic nanoparticles ($CoZnFe_2O_4$) with silica encapsulation have been successfully synthesized by using coprecipitation method. The concentration of silica was varied by 0%, 5%, 10%, 15%, 20%, 30% and 50% of weight. The Si_2O_3 solution was used as a starting materials for the formation of silica layer. The X-ray diffraction (XRD) characterization was carried out to identify the crystal structure for both unencapsulated and encapsulated $CoZnFe_2O_4$ nanoparticles. The unencapsulated $CoZnFe_2O_4$ has particles size of 2.5 nm. The encapsulated samples have particles size which slighly increase with increasing silica concentration up to 2.7 nm. The unencapsulated $CoZnFe_2O_4$ nanoparticle has coercivity (Hc) of 250 Oe.

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. $CoZnFe_2O_4$ nanoparticles were prepared by chemical coprecipitation method. The materials used were $FeCl_3.6H_2O$, $ZnSO_4.7H_2O$, $CoCl_2.H_2O$, 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)

Fig. 1 show that there are significant changes because of the presents of PVA and PVA+MA on the surface of Au thin films.At the lower energy, the Δvalues are relative increased as a function of the growth time (days), but at the higher energy the Δvalues are relative decreased. Fig. 2 show AFM

image of Au thin film.

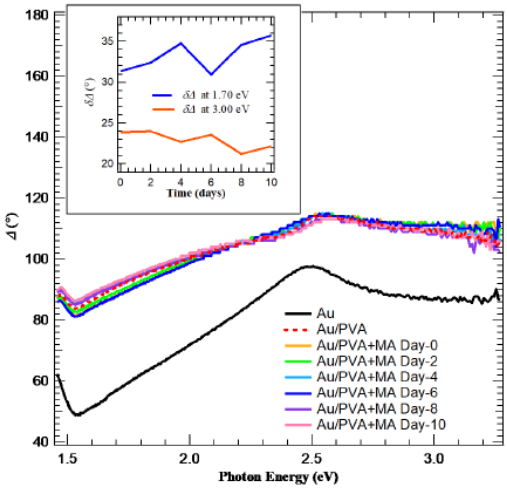

Fig. 1. The Δvalues of Au, Au/PVA, andAu/PVA+MA.

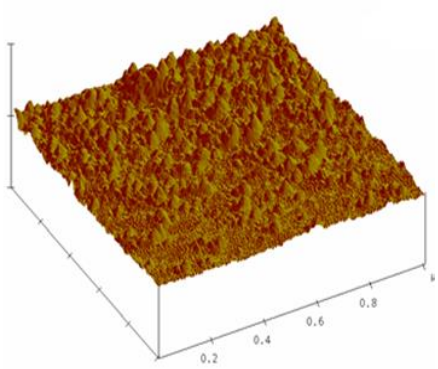

Fig. 2. AFM image of Au thin film.

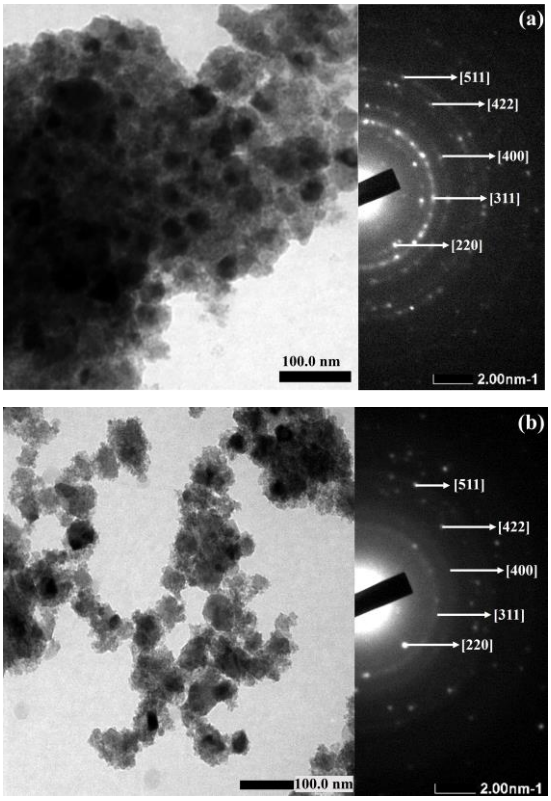

Fig. 3. TEM images of $CoZnFe_2O_4$: (a) as prepared, (b) Encapsulated by silica 50%.

The morphology and selected area electron diffraction (SAED) image of $CoZnFe_2O_4$ nanoparticles before and after silica encapsulated as shown in Fig.2. Fig. 2 (a) shows the TEM images of SiO_2 unencapsulated nanoparticles. It has been observed that the nanoparticles are agglomerated with the grain size of about 23.5 nm. Agglomeration due to the strong interaction between the nanoparticles and the high reactivity of the nanoparticle surface. While Fig. 2 (b) shows the TEM images of SiO_2 encapsulated nanoparticles. It has been showed that the grain size of the nanoparticles slightly decreases to 15.5 nm.

4. その他・特記事項(Others)

・Collaborators：Satoshi Iwata (IMaSS, Nagoya Univ.), Takeshi Kato (Graduate School of Engineering. Nagoya Univ.)

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

[1] S. N. Alfath, et al., “Optical Signatureof Microalgae Growth Studied using Spectroscopic Ellipsometry-based Biosensor”, International Conference on Optical and Photonic Engineering, Shanghai, China, 8-11 May 2018.

[2] L. O. Rusman, et al., “Crystal Structures and Magnetic Properties of Silica-Encapsulated CoZnFe2O4 Magnetic Nanoparticles”, the 5th International Conference of Asian Union of Magnetics Societies (ICAUMS 2018), Jeju, Korea, 3-7 June 2018.

[3] H. Kiswanto, et al., “Effect of Annealing Temperature on Crystal Structure and Magnetic Properties of CoZnFe2O4 Magnetic Nanoparticles”, the 5th International Conference of Asian Union of Magnetics Societies (ICAUMS 2018), Jeju, Korea, 3-7 June 2018.

6. 関連特許(Patent)

None