Modication of Gold Active Layer for Detection Cobalt Ion Via Surface Plasmon Resonance Spectroscopy

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Abstract: In this study, gold layer has been modified by introducing chitosan-graphene oxide-cadmium sulfide quantum dots on the gold layer for the detection of cobalt ion, Co^{2+}. The composite material was deposited on the gold layer by using spin coater machine. The thin film was used as an active layer for the detection of Co^{2+} using surface plasmon spectroscopy and the optical changes of the thin film after contacting with different concentration of Co^{2+} ions had been obtained and graph fitted. The resonance angle shifted to a higher value as the concentration of Co^{2+} ions was increased. Changes of the resonance angle showed that Co^{2+} ion does react with the modified thin film with a binding affinity of 3.03 M^{-1}.

***Keywords*:** Active layer, resonance angle, thin film.

INTRODUCTION

Surface plasmon resonance is a versatile technique for sensing application. It has been used and successfully applied in several application such as disease monitoring, drug discovery, metal ion detection and so much more [1]. Surface plamon resonance is a phenomena where energy from EM radiation such as light interact with free electron on the metal-dielectric interface that then converted into surface plasmons from the absorption of the energy [2]. With the introduction of an active layer, interactions between the targeted metal ion may change the refractive index of sensing surface which was resulted from the binding of metal ion and the active layer which will shift the resonance angle. This unique phenomenon of SPR has been utilized as an optical sensing principle. However, there are limited studies on the determination of Co^{2+} using surface plasmon technique. In addition, one of the recent novel material is the quantum dots materials. Cadmium sulfide quantum dots is one of the quantum dots family and they are unique due to its nano-size particles. Some studies have been conducted for metal ion sensing using CdS QDs material. However, most of the studies reported that CdS QDs was used in the Fluorescence sensor and as far as concerned, there is still no study on the metal sensing application of CdS QDs using SPR technique. So, in this study the CdS QDs was synthesized and was mixed with chitosan and graphene oxide and applied into the SPR technique for the determination of Co^{2+} ion

MATERIALS AND METHODS

At first, chitosan solution was prepared by dissolving 0.4g of medium molecular weight chitosan that was purchased from Aldrich with 50ml of the 1% acetic acid [3]. After that, 10ml of readily purchased graphene oxide solution was added into the chitosan solution and stirred.

The cadmium sulfide quantum dots was prepared by a simple wet process done by Hazani et al. [4]. It begins by dissolving 0.5 mmol of MPA and 0.5 mmol of $CdCl_2.10H_2O$ by adding 250 ml of ddH_20 water in 500 ml beaker. Then the pH of the solution was adjusted to 6.0 by adding dropwise of NaOH solution (1M) with constant stirring. Subsequently, the solution was purged with nitrogen gas for at least 60 min under vigorous stirring. Sodium sulfide ($Na_2S.9H_2O$) (0.5 mmol) was then added

dropwise into the stirred solution until the clear yellowish suspension of CdS QDs was obtained. Finally, 10 ml of chitosan, cadmium sulfide quantum dots, and graphene oxide solution was stirred with a magnetic stirrer for 1 hour and then sonicated again for one hour. For the preparation of thin film, the glass slides were first deposited with a thin gold layer using an SC7640 sputter coater [5]. Then, the spin-coating technique (Specialty Coating System, P-6708D) was used and was spun at 4000 rev/min for 30 s to produce the composite thin film. The SPR experiment was done with increasing concentration of Co^{2+} ion solution changed one after another and the reflected beam was detected by sensitive photodiode. The Obtained data was plotted to get the SPR curve.

RESULTS AND DISCUSSION

Data obtained from the SPR experiments were plotted into SPR curves as shown in Fig. 1. It can be seen that as the concentration of Co^{2+} ion increased, the SPR curves were shifted to the right. This shows that the active layer does give a positive result as a sensing layer for the detection of Co^{2+} ion. The maximum angle shift is observed at 100 ppm with 0.2159°. The interaction of Co^{2+} ion with the synthesized active layer was confirmed by the Langmuir isotherm model fitting on the angle shift against concentration plotting as shown in Fig. 2. The correcation coefficient, R^2 obtained from the fitting is considerably high at 0.89355 and the binding affinity constant is 3.03 M^{-1}. With this results, it is clear that Co^{2+} does interact with the modified active layer.

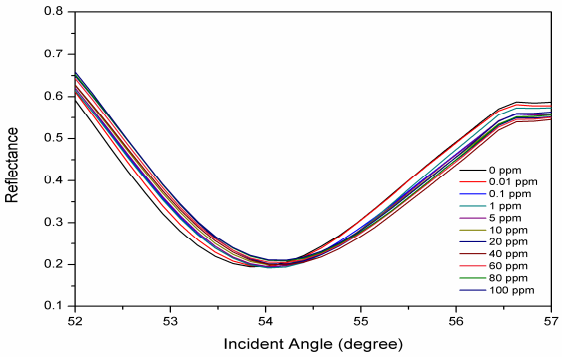

Fig. 1. SPR curves of Co2+ ranging from 0 ppm to 100 ppm

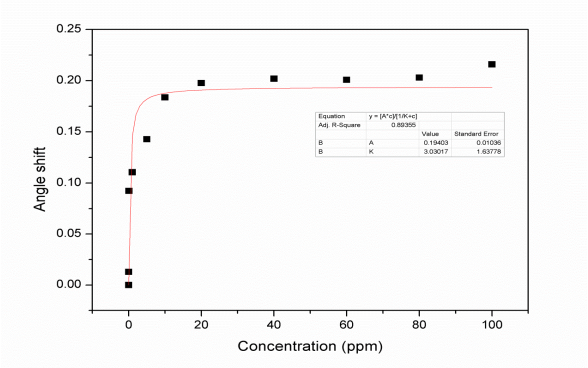

Fig. 2. Langmuir isotherm model of the SPR angle shift for Co2+ ions

CONCLUSIONS

As a conclusion, the results show that the modified gold active layer of chitosan-GO-CdS QDs gives a positive response for the detection of Co^{2+} ions. However, the synthesized thin film is not suitable to be used for higher concentration of Co^{2+} ion.

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