Journal of Physics: Conference Series

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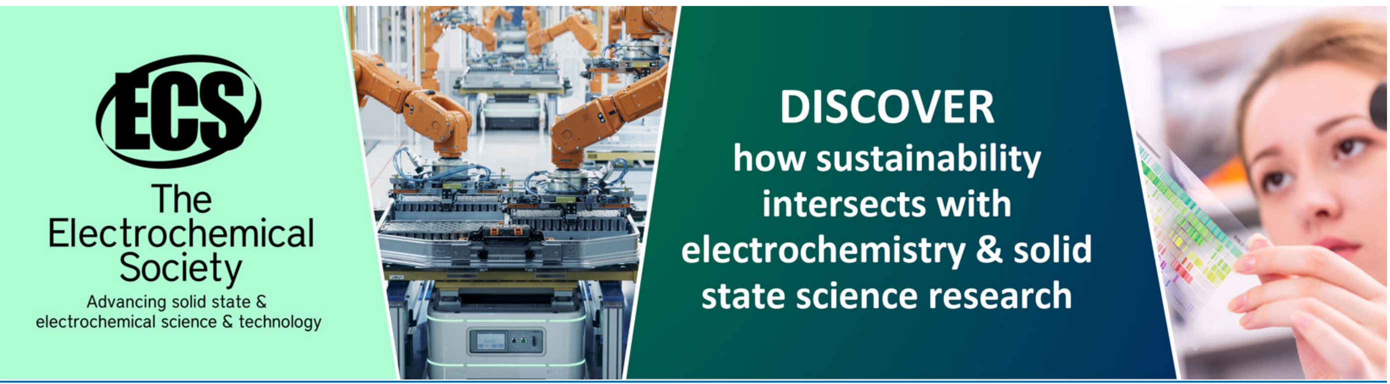
To cite this article: C L McClatchey *et al* 2011 *J. Phys.: Conf. Ser.* **286** 012004



Journal of Physics: Conference Series **286** (2011) 012004 doi:10.1088/1742-6596/286/1/012004

Fabrication and optical properties of gold nanowire arrays

C L McClatchey, A Murphy, J McPhillips and R Pollard

School of Mathematics and Physics, Queen's University of Belfast, University Road, Belfast, BT7 1NN

cmcclatchey01@qub.ac.uk

Abstract. In this work the optical properties of arrays of gold nanowires in transmission and attenuated total reflectance (ATR) geometry has been examined further, with a view to maximising the sensitivity by finding optimum nanowire and array dimensions. Gold nanowire arrays were grown by electrochemical deposition into a nano-porous alumina template. The effect of changing the nanowire aspect ratio on the optical properties was investigated.

1. Introduction

The potential of noble metal nanostructures in the field of plasmonic sensing is well known [1-3] due to the high sensitivity of the plasmonic resonance to small changes in the surrounding dielectric environment. This sensitivity has been exploited recently to perform label-free biosensing measurements, in both transmission [3] and attenuated total reflectance (ATR) geometries [4], on substrate-bound nanowire arrays. ATR measurements on a non-optimised array of gold nanowires immersed in a range of aqueous solutions of glycerine of different concentrations showed a sensitivity of 30,000nm/RIU [4]. This is two orders of magnitude higher than that currently offered by conventional SPR-based sensors [5].

2. Fabrication and Results

Gold nanowire arrays with differing aspect ratio and inter-wire spacing were grown by electrochemical deposition into a nano-porous alumina template. The diameter and spacing of the nanowires formed was varied by altering the anodisation and deposition parameters. The length of the nanowires was controlled by monitoring in-situ optical extinction measurements during the gold deposition.

When illuminated with plane polarized light above the critical angle, a plasmonic mode is observed as a resonance in the near-IR region in the reflectance spectrum. This mode is non-localised and is in fact guided in nature; it exists in the thin sub-wavelength slabs of the nanowires. Figure 1 shows the change in resonant position as the angle of incidence is changed. The effect of changing the nanowire array geometry was studied experimentally by creating two nanowire samples with the same height but different diameters. It was found that decreasing the aspect ratio of the nanowires led to a blue-shift in the ATR resonance position, as shown in Figure 2.

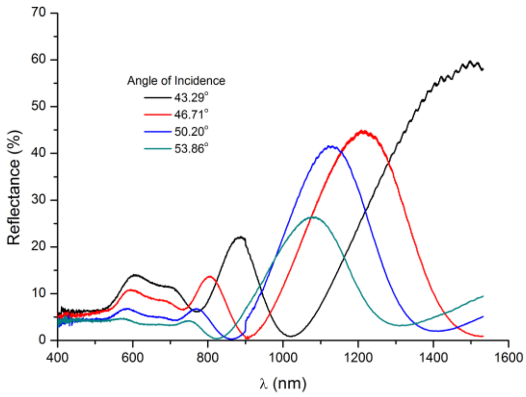


Figure 1 Graph showing reflectance of an array of gold nanowires embedded in alumina over a number of angles of incidence. The resonant mode is highly sensitive to changes in the refractive index between the wires.

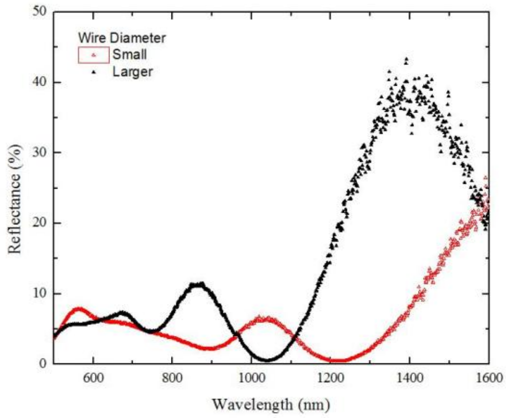


Figure 2 Graph showing shift in ATR spectrum with changing aspect ratio. The wires with larger diameter have a more blue-shifted resonance than those with smaller diameter.

3. Outlook

Since the plasmonic resonance observed in nanowire arrays illuminated in ATR geometry is highly sensitive to small changes in the refractive index of the material surrounding the nanowires means they have a large potential for biological sensing applications. We have already demonstrated the tunability of this resonance by fabricating nanowire arrays with differing aspect ratio; we now wish to find use finite element modelling based on Maxwell's equations to a quantitative explanation of the experimental results.

References

[1] Liedberg B, Nylander C and Lundstrom I, *Sensors and Actuators* **4** (1983)
[2] Jonsson M P, Dahlin A B, Jönsson P, Höök F, *Biointerphases* **3** (2008)
[3] McPhillips J, Murphy A, Jonsson M P, Hendren W R, Atkinson R, Höök F, Zayats A V and Pollard R J, A*CS Nano* **4** (2010)
[4] Kabashin A V, Evans P, Pastkovsky S, Hendren W, Wurtz G A, Atkinson R, Pollard R, Podolskiy V A and Zayats A V, *Nature Materials* **8** (2009)
[5] Anker J N et al., Biosensing with Plasmonic Nanosensors, Nature *Materials* **7** (2008)