Gold nano-fin array for far-infrared enhancement

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When surface plasmons are excited on the metal surface, electromagnetic field density is dramatically increased. By introducing this field enhancement characteristic to the far-infrared spectroscopy, high sensitive detection and characterization of the fingerprint of materials can be expected. However, surface plasmons are unfortunately not supported in the far-infrared spectral region because of the dispersion properties of the metals. To overcome this limitation, many ideas on artificial modification of the surface of metal such as forming an array of holes are proposed. In this paper, we will propose another route to fabricate artificial structures that can accumulate infrared light energy with wafer-scale fabrication area.

As a metal structure that can support surface plasmon-like wave, we propose an Au nano-fin array. Au nano-fin arrays on Cr film were prepared using "sidewall lithography" technique [1]. At the first setout, a Cr film with 100-nm in thickness was formed on a Si substrate. A resist template with line pattern was photolithographically formed on the Cr film. Au thin film with 80-nm in thickness was sputtered on the sample surface. The sample was subjected to Ar plasma to remove the top layer of Au films and only the Au films on the sidewall of the resist template were remained. Finally, the resist was removed by O_2 plasma gas and vertically self-standing Au nano-fins were formed (Fig. 1(a)).

The reflection spectra of the Au nanofin arrays were characterized using an FT-IR with various incident angles, incident directions to the fin structure (parallel and vertical), and polarization directions (p- and s-pol.) shown in Fig. 1 (b). Figure 2 shows reflection spectra of Au nano-fin array of four possible combinations of polarizations and incident directions (p-parallel, p-vertical, s-parallel, and s-vertical). As shown in Fig. 2, only under the condition of p-vertical, resonant absorption peaks are observed.

Figure 3 shows reflection spectrum change according to the incident angles. Figure 3(a) shows an experimental result taken by FT-IR and Fig. (b) shows a calculation result done by Rigorous Coupled Wave Analysis (RCWA). These two results show good agreement and dispersion properties of absorption peaks are clearly observed.

In the presentation, electromagnetic properties of Au nano-fin array and their application for gas sensor will be shown.

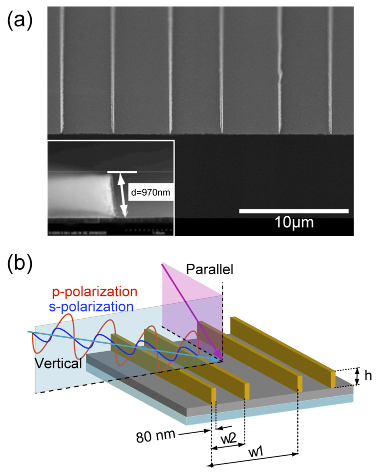

Figure 1. (a) Scanning electron micrograph of Au nano-fin arrays. The inset is the enlarged cross-sectional image. (b) Schematic image of Au nano-fin arrays and spectral measurement of them.

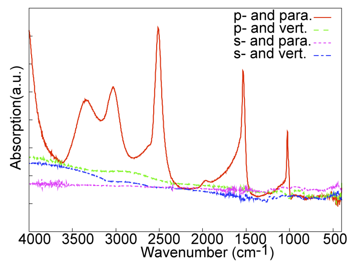

Figure 2. Reflection spectra of Au nano-fin according to p- and s-, and vertical and horizontal incident conditions.

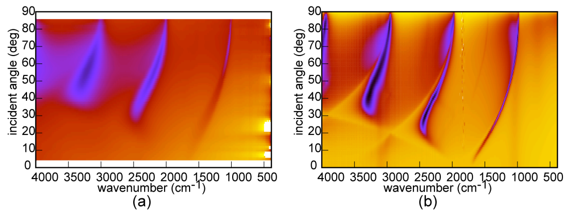

Figure 3. (a) Experimental result of reflection spectra of Au nano-fin array according to the incident angle change. (b) Numerical calculation result by RCWA.

[1] S. Fujikawa, R. Takaki, and T. Kunitake, *Langmuir* **22**, 9057 (2006).