

課題番号 : F-13-UT-0054  
利用形態 : 機器利用  
利用課題名 (日本語) : 3次元光学結晶のための立体積層技術に関する研究  
Program Title (English) : Fabrication Technology for Three Dimensional Metallic Photonic Crystal Slab  
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## 1. 概要 (Summary)

Optical resonances with light wave vectors in a photonic crystal (PhC) slabs depend on the shape, size, period, and thickness of the structures. In case of the metallic PhC, there has been a limitation to control the thickness of the metallic structures, more especially thick metallic structures. In this paper, the new fabrication technology for three dimensional metallic PhC with thick metallic structures has been demonstrated. To realize the thick metallic PhC, e-beam lithography with thick resist, gold sputtering with rotating tilted stage, and reactive ion etching with argon and tetrafluoromethane were performed. The measured absolute reflectance spectra of fabricated three dimensional metallic PhC were studied as a function of the incident light wave angle from the visible region to near infrared region. It was found that fabricated three dimensional metallic PhCs show resonance peaks in the light wave region.

## 2. 実験 (Experimental)

To realize three dimensional Au PhC, a new fabrication method for three-dimensional metallic structure arrays was used. A thick electron beam resist (OEBR-CAP112, Tokyo Ohka Kogyo) was spin-coated on a silicon (Si) substrate with a thickness of 1.5  $\mu\text{m}$ . An electron beam lithography process was performed with an electron beam lithography apparatus (F5112 + VD01, Advantest). After a development process with tetramethylammonium hydroxide, Au was sputtered on the developed resist conformally by magnetron sputtering apparatus with rotating tilted stage (SC-701HMCII, Sanyu Electron). Then, a reactive ion etching process (RIE-10NR, Samco) with a gas mixture of argon (Ar) and tetrafluoromethane ( $\text{CF}_4$ ) was performed to remove Au on the top of the developed

resist and the Si substrate. Finally, oxygen ( $\text{O}_2$ ) plasma was applied to the sample to remove the remaining resist within the high aspect ratio Au structures. Scanning electron microscope images of the fabricated Au PhC are presented in Fig.1. The thickness of the Au layer was 50 nm. Height of the Au walls was 500 nm. The period of the Au PhC was 1  $\mu\text{m}$ .

## 3. 結果と考察 (Results and Discussion)

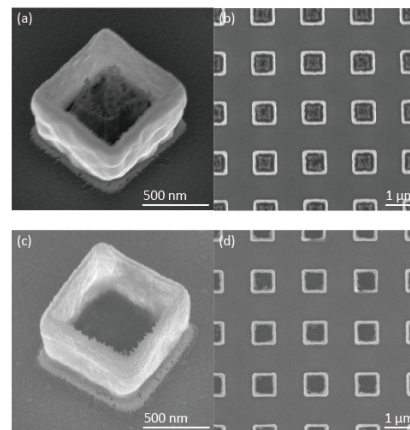


Fig.1 Scanning electron microscope image of the fabricated Au PhC. (a) and (b) are the images of Au PhC with resist. (c) and (d) are the images of Au PhC without resist after  $\text{O}_2$  plasma process. (a) and (c) are the tilted view. (b) and (d) are the top view of Au PhC.

## 4. その他・特記事項 (Others)

なし

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

Etsuo Maeda, "Fabrication technology for three dimensional metallic photonic crystal slab," IEEE NEMS 2014, Waikiki beach, Hawaii, USA.

## 6. 関連特許 (Patent)

なし