

課題番号 : F-18-TU-0028  
 利用形態 : 機器利用  
 利用課題名(日本語) : MEMS/NEMS fabrication  
 Program Title (English) : MEMS/NEMS fabrication  
 利用者名(日本語) : Nguyen Van Toan  
 Username (English) : Nguyen Van Toan  
 所属名(日本語) : 東北大学大学院工学研究科  
 Affiliation (English) : School of Engineering, Tohoku University  
 キーワード/Keyword : 膜加工・エッチング, 成膜・膜堆積, Nanochannels, Ion transport, Thermo-electric power generator.

## 1. 概要(Summary)

Thermal-to-electric energy conversion based on a fluidic transport in nanochannels induced by a temperature gradient is investigated. Highly ordered periodic and high aspect ratio anodized aluminum oxide (AAO) nanochannels with 10 nm-diameter and 3 μm-length are successfully fabricated by an anodic oxidation process in a diluted acid electrolytic solution. Thermal-to-electric energy conversion using above AAO nanochannels has been demonstrated.

## 2. 実験(Experimental)

### 【利用した主な装置】

- ・Vapor HF エッチング装置
- ・エッチングチャンバー
- ・多元材料原子層堆積(ALD)装置
- ・メタル拡散炉
- ・サンドブラスト装置
- ・両面アライナ露光装置一式(両面アライナ、スピスコータ、オープン、現像機、乾燥機)

### 【実験方法】

Wafer with 3 μm-thick aluminum film is immersed in the 0.1 mol/L H<sub>2</sub>SO<sub>4</sub> electrolyte with electrical connection to outside for the potential voltage supply. Anodic oxidation process of the aluminum film is carried out using three electrochemical systems. The anodic oxidation process is performed at room temperature at a constant potential of 5 V while the anodic oxidation current is monitored. The electrical current is dramatically decreased and come to near 0 mA after approximately 30 minutes which indicates that the entire aluminum is anodized

## 3. 結果と考察(Results and Discussion)

Forming nanochannels with 10 nm-diameter and

3 μm-height is as shown in Fig. 1.

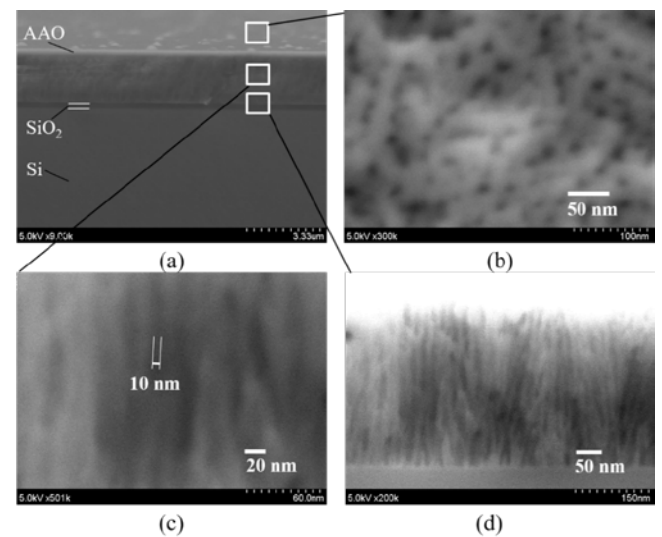


Figure 1. Highly ordered periodic and high aspect ratio nanochannel aluminum oxide. (a) Cross sectional view after anodic oxidation process. (b) Magnification image of top surface of wafer showing 10 nm-diameter of AAO nanochannels. (c) and (d) are middle and bottom area-cross sectional view showing 3 μm-length – AAO nanochannels with vertical shape.

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

- (1) N.V. Toan, M.M.I.M. Hasnan, D. Udagawa, N. Inomata, M. Toda, S.M. Said, M.F.M. Sabri and T. Ono, “Electrolyte based thermal to electric energy conversion utilising on 10 nm diameter of Al<sub>2</sub>O<sub>3</sub> nanochannels”, *IEEE-MEMS 2019*, 507-510, Seoul, Korea, Jan. 27-31, 2019.

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

なし

## 6. 関連特許(Patent)

なし