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利用形態　:共同研究
利用課題名（日本語）　:
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利用者名（日本語）　:李光立
Username (English)　:Kuang-li Lee
所属名（日本語）　:台湾中央研究院応用科学研究中心
Affiliation (English)　:Research Center for Applied Sciences, Academia Sinica, Taiwan
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1. 概要（Summary）

Label-free sensing techniques for observing dynamic cell activities can facilitate cell biological studies, immunotherapy and drug discovery. We propose Fano resonances with dual penetration lengths in capped aluminum nanoslit arrays for real-time and label-free cellular adhesion analysis. The unique optical property of dual penetration lengths was verified by the finite-difference time-domain calculations and experimental estimation through refractive index and surface (thickness) sensitivity tests.

2. 実験（Experimental）

【利用した主な装置】

超高精度電子ビーム描画装置 (ELS-F125), ヘリコンスパッタリング装置 (MPS-4000C1/HC1), 高分解能電界放射型走査型電子顕微鏡 (JSM-6700FT), 反応性イオンエッチング装置 (RIE-10NRV)

【実験方法】

Capped aluminum nanoslits with a slit width of 60 nm, a ridge height of 60 nm and a period of 470 nm were fabricated on a polycarbonate (PC) substrate. First, a 470-nm-period nanogroove array with an area of 5 mm x 5 mm, a trench depth of 100 nm and a slit width of 60 nm was fabricated on a Ni-Co mold using electron beam lithography and electroplating. The metal stamp was utilized to replicate nanoridge arrays on the plastic film using hot-embossing nanoimprint lithography. After depositing a 40-nm-thick aluminum film on the plastic nanostructure, the capped aluminum nanoslit arrays were made.

3. 結果と考察（Results and Discussion）

In this study, we proposed capped aluminum nanoslit arrays with dual penetration lengths for real-time and label-free cellular adhesion analysis. This approach provides a dual sensing range and 4-parameter plots to describe the long-range and short-range cell adhesion behaviors such as the cell morphology change and mass redistribution within cells. When transverse-magnetic (TM)-polarized white light is normally incident on the nanoslit structure, three kinds of resonance modes can be excited in the transmission spectrum. There are gap plasmon resonances in nanoslits and Bloch wave surface plasmon polaritons (BW-SPPs) and Wood's anomaly on both sides of the periodic aluminum surface. Compared to the conventional gold-based SPR sensors with penetration lengths of 100-300 nm, the capped aluminum nanoslit array has a longer sensing range and dual penetration lengths, which can be utilized to simultaneously study the cell behaviors near and far from the metal surface.

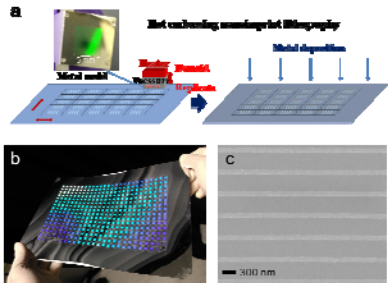

Fig. 1 Fabrication of metallic nanostructures. a, Fabrication flowchart of metallic nanostructures using hot embossing nanoimprint lithography and thermal evaporator. b, Optical image of capped aluminum nanoslit arrays on an A4-sized polycarbonate film. c, SEM image of the capped aluminum nanoslits.

4. その他・特記事項（Others）

・共同研究者: X. Shi, T. Oshikiri, Q. Sun, H. Misawa and Y. Matsuo（北海道大学）

5. 論文・学会発表（Publication/Presentation）

論文：K-L, Lee, *et al.*, Injection compression molding of transmission-type Fano resonance biochips for multiplex sensing applications, *Appl. Mater. Today*, 2019, 16, 72-82.

6. 関連特許（Patent）　なし