Fabrication of Plasmonic Nanoantenna with Mid-infrared Niobium-Doped Titanium Dioxide

Hai Dang Ngo[1, 2], Kai Chen[1, 3] , Tung Anh Doan[1,2], Orjan S. Handegard[1,2], Thien Duc Ngo[1, 2], Duy Thang Dao[1] , Naoki Ikeda[1, 4], Akihiko Ohi[1,4], Toshihide Nabatame[1, 4], and Tadaaki Nagao[1, 2, *]

[1]International Center for Materials Nanoarchitectonics, National Institute for Materials Science, Tsukuba 305-0044, Japan

[2]Department of Condensed Matter Physics, Graduate school of Science, Hokkaido University, Kita-10 Nishi-8 Kita-ku, Sapporo 060-0810, Japan

[3]Institute of Photonics Technology, Jinan University, Guangzhou, 510632, China

[4]Nanotechnology Innovation Station, National Institute for Materials Science, Tsukuba 305-0044, Japan

***Email**: NAGAO.Tadaaki@nims.go.jp

Abstract: Among conductive oxide materials, niobium doped titanium oxide has recently emerged as a stimulating and promising contestant for numerous applications. With carrier concentration tunability, high thermal stability, mechanical and environmental robustness, this is a material-of-choice for surface plasmon photonics in the infrared region. In this report, to illustrate great advantages of this material, we describe successful fabrication and characterization of niobium doped titanium dioxide nanoantenna arrays aiming at surface-enhanced infrared absorption spectroscopy. The niobium doped titanium oxide film was deposited with co-sputtering method. Then electron beam lithography was used to write strip and circle nanopatterns onto spin-coated polymer resist layer. The structure went through reactive plasma etching and oxygen plasma ashing processes to remove remaining resist as well as unnecessary parts of oxide film.

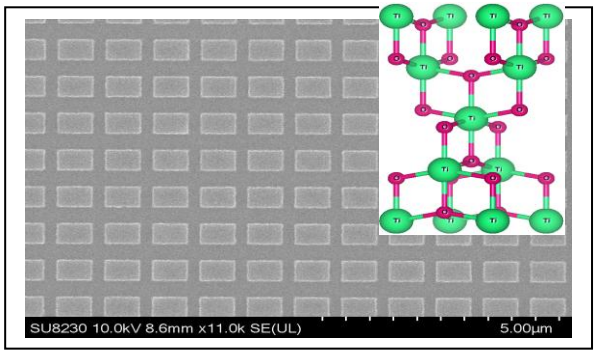

Figure 1: SEM image of nanoantenna. Strip size 750 nmx 500 nm. Inset: Anatase TiO2 structure.

Relative transmittance of nanostrips and nanodisks in the antenna arrays was evaluated with Fourier transform infrared spectrometer. Resonances from confined surface plasmons exhibit strong polarization dependence on incident light and good agreement with calculations. Simulated spectra also present red shift as length, width or diameter of the nanostructures increase, as predicted by classical antenna theory.

Keywords: Nb doped TiO2, plasmonic, infrared, nanoantenna, plasmon resonance