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Generation of near-field lights at an edge-sharpened nanoslit

Tokyo Institute of Technology, ○Himasha R. Dharmapala, Tsukasa. Negishi, Haruhiko. Ito

E-mail: dharmapala.h.aa@m.titech.ac.jp

We are planning to precisely control atoms and spins with near-field lights for the creation of atomic-scale functional and spin functional tips and devices. To this end, it is important to detect atoms with high-spatial resolution exceeding 100 nm. So, we are developing an atom detector by means of the two-step photoionization with two-color near-field lights generated at a nanoslit. The resultant near-field light strongly depends on the radius of curvature of the slit edge [1]. When the edge gets dull, near field light is drawn into the slit and extends transversally decreasing the peak intensity [2]. This time, we fabricated a nanoslit with a sharpened edge whose radius of curvature is below 30 nm to improve the s-polarization excitation in the short wavelength region.

To sharpen the edge, we first coat Ti on the Al thin film and etch it. Fig. 1 shows the SEM image of the fabricated nanoslit with a 50-nm-thick Al coat, where the slit depth is 116 nm, and the radius of curvature is 31.07 nm in the left and 37.59 nm in the right. Fig. 2 indicates the cross-sectional intensity distribution obtained by FDTD simulations in the case of the wavelength of 476.5 nm used for the Rb detection. The peak intensity of near-field light is 2.04×10^{-7} W/m^2 for s-polarization, while 1.49×10^{-8} W/m^2 for p-polarization. We will also report the SNOM experiments.

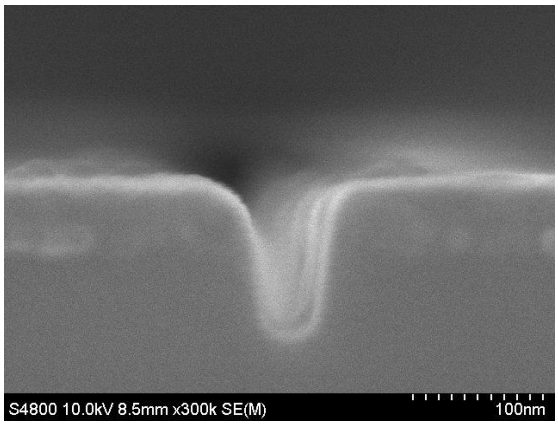

Fig. 1: SEM image of the cross section of the 50-nm-wide nanoslit with a sharpened edge.

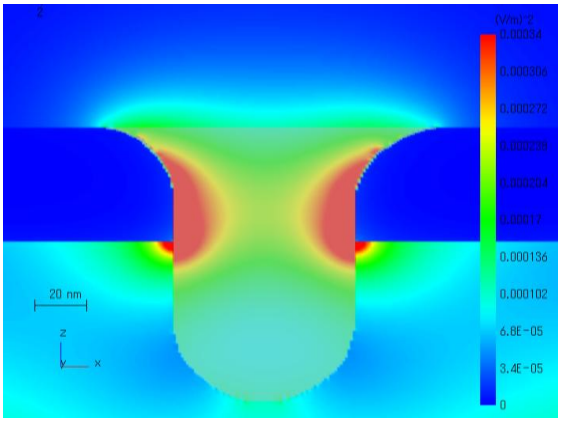

Fig. 2: Intensity distribution in the cross section of the nanoslit obtained from FDTD simulations in the case of the s-polarized 476.5-nm excitation light.

[1] T. Sato, H. Ito, “Generation of near-field light at a nano-slit with rounded edges,” *J. Nanophotonics* 5 (2011).

[2] H. Ohki, T. Sato, T. Negishi, H. Ito, “Dependence of wavelength on generation of near-fields at a nano slit ”, *59th The JSAP Spring Meeting* 2012