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Surface Plasmon Resonance Of High Power Laser Field

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We investigated high intensity electric field generation using surface plasmon resonance of high power laser field. Surface plasmons are delocalized electron oscillations near the surface boundary and can be resonantly oscillated by using a prism, a grating or a defect on the metal surface having a negative dielectric constant. When surface plasmon resonance occurs, the electric field intensity in the vicinity of the surface boundary can be enhanced. This phenomenon has been widely applied to biomedical and chemical sensors or Raman spectrometers. But the excitation of surface plasmon resonance using a high power laser has not been well studied.

To cause surface plasmon resonance effectively, we used gold gratings, the shape of which must have been optimized. After deciding the groove period, the groove depth and the base depth by FDTD simulation, using a high power laser ($I_0 = 1.1 \times 10^{18}\,\mathrm{W/cm^2}$) and the gratings, we carried out an experiment to confirm the surface plasmon resonance at the ultra intense laser field. We measured the reflected spectrum from the grating target, and emission angles of accelerated electrons. The result showed the depression in the reflection light shown in Fig. 1 and the increase of in-plane direction electrons. These results clearly implies the existence of surface plasmon resonance using high power laser and therefore enhancement of the local electric field. Also, we shows the possibility of controlling the direction of accelerated electron beam with the surface plasmon resonance.

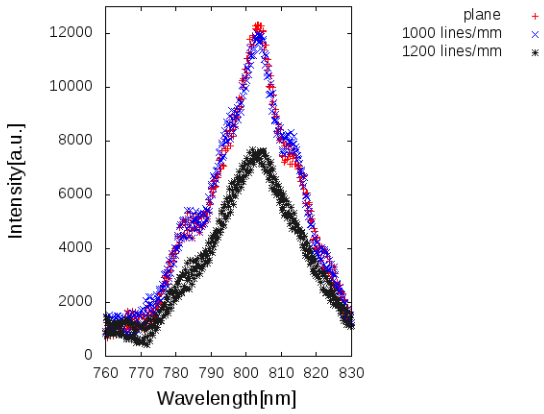

Fig. 1. Measured reflected spectrum with two different gold gratings and a gold plate. The grating with 1200 lines/mm obviously shows the depression of the reflection light.