Surface plasmon focusing and its application to refractive index imaging

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Introduction

Surface plasmons excited on a flat metal surface propagate with a certain propagating constant depending on refractive index in the near field of the metal surface. Since this dependency is strong enough to detect refractive index change by molecular level adsorption onto the metal surface, surface plasmons are intensively applied to detection of molecular interactions. As shown in Fig. 1, surface plasmon focusing is a technique to converge these propagating surface plasmons, and the technique enables localization of the surface plasmons in a sub-micron region. By using this technique, imaging of refractive index distribution on the metal surface can be conducted.

In this talk, detailed properties of surface plasmon focusing, a microscope using surface plasmon focusing, and improvement of spatial resolution by using confocal detection are introduced.

Surface plasmon focusing and its application to microscopy

Figure 2 shows a standard optical setup of the focused surface plasmon microscope. In this setup, illumination light is converged to a substrate with Kretschmann configuration. The spatial frequency of the reflected light is analyzed to find a propagating constant of the focused surface plasmon k_{sp}, which can be converted to effective refractive index. By scanning the substrate, an effective refractive index distribution can be obtained. The microscope has been applied to observe structure of bio-membrane, cellular adhesion sites, cell-substrate gap distance distribution, and so on.

Further improvement of spatial resolution is also achievable by using confocal detection system. In this case, ring pupil illumination is employed to have a condition in which reflected intensity is affected by refractive index of a sample. Theoretical calculation shows that the full width at half maximum of the point spread function is improved by ~30%.

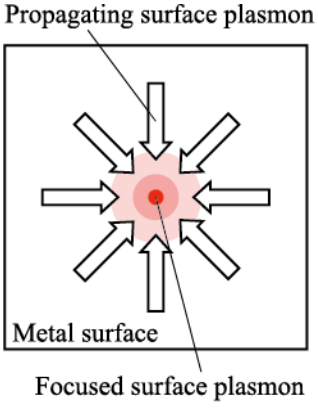

Figure 1. Surface plasmon focusing

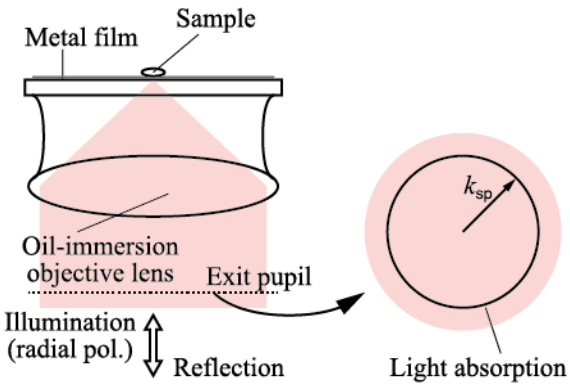

Figure 2. Focused surface plasmon microscopy