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物性コロキュウム

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場所: 理学部 総合研究棟 745号室 (大学院講義室 I)
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題目 : Surface Plasmon Enhanced Photon Drag Effect in Metal films

要旨: It is well known that when photons are incident on the surface of an electrically conducting material like a semiconductor, they can induce a surface current due to the second order nonlinear optical effect known as photon drag. Here, the photons essentially impart their momentum to the charged carriers (like electrons). This effect has been observed for semiconductors and is used for detecting ns high peak power laser pulses in the mid-infrared. Although the photon drag effect is expected to occur for metals, this has not been observed, to our knowledge. One reason for this is that the effect is weak in metals due their high reflectivity in the visible and the infrared. Here, we present the results of our observation of the photon drag effect in a Au film in the form of a significantly enhanced electrical signal induced by optical excitation. This becomes possible when the incident photons excite a surface plasmon resonance in the Au film. For this, we mount the Au film in the so called Kretschmann-Raether configuration. Here, the Au film is attached to the flat surface of a half cylindrical prism. At resonance, the photons incident from the prism side can get completely absorbed in the Au film by excitation of a surface plasmon at the Au/air interface. This leads to a clearly measurable surface current in the Au film. For our experiments, we deposit 47nm thick Au film on a glass slide substrate with a 3nm thick Cr layer predeposited for good adhesion of the Au film. The Au film is shaped into a strip geometry of size 25mm x 0.7mm and electrical contacts are made at the two ends of the strip. For optical excitation, ns pulses from a Nd-YAG laser at a wavelength of 930nm are incident on the Au strip from the prism side. The peak power density in the laser spot is about $1MWcm^{-2}$ and the pulse width is 5ns. Sharply enhanced signal is seen at the surface plasmon resonance at $\theta=42^0$. When the angle of incidence is reversed, the signal changes sign. This is consistent with the behavior expected in the photon drag effect. We propose a model to understand the dynamics of surface plasmon excitation, relaxation and generation of electrical signal in the Au film.

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