The Dispersion Relations of the Sub-skin-depth Metal Particles

S. C. Chen
Far East College, Taiwan

T. M. Chang and D. P. Tsai
National Taiwan University, Taiwan

According to Maxwell's equations, if sizes of conductors are much larger than the incident wavelength, the electromagnetic fields are forbidden inside the conductor, only a very thin layer is penetrated by electromagnetic fields, this thin layer is the so-called "skin depth". Under optical waves, the skin depth is about 20 nanometers for noble metals, thus, if the size of the metal particle is less than the skin depth, the particle will be possible to be full of the electromagnetic fields. Based on such point of view, it is easy to understand why the absorption of optical waves only happened in sub-micro particles [1].

There are some interesting phenomena should be further studied in the sub-skin-depth optics. For example, the internal electric field of the optical wave can excite volume plasmons, for classical electromagnetic theories, volume plasmons can be excited only when the incident frequency is higher than the plasma frequency [2]. It means that both the surface plasmon and volume plasmon are able to coexist in sub-skin-depth space, the coupling of these two type plasmons suggests that the dispersion relation of the sub-skin-depth particle should be quite different from the classical one. We will try to derive the novel dispersion relation from fundamental theories and verify it by experiments and numerical simulations.

REFERENCES

1. Messinger, B. J., K. U. Von Raben, and R. K. Chang, "Local fields at the surface of noble-metal microspheres," *Phys. Rev. B*, Vol. 24, No. 2, 649, 1981.
2. Raether, H., "Surface plasmons on smooth and rough surfaces and on gratings," Springer-Verlag, 1988.