Measurement of nano-particles size by evanescent interference field with conventional optical microscope

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It is well known that particles under diffractively limited size can not be observed by conventional optical microscopes. In our study, we propose a novel measurement in which the scattering light contrast of nano-particles is measured during continuous shifting fringes of evanescent interference field. As a result, by comparing the experimental contrasts to theoretical values, the particle size can be calculated.

In the situation that light propagates from lower refractive index material into higher one with the incident angle larger than the critical angle, evanescent wave would exist in several hundreds nanometers. According to the photon tunneling effect, evanescent wave can be frustrated into scattering light of which the brightness absolutely depends on the local intensity. In this study, evanescent interference field is introduced to induce the scattering light being continuously modulated during shifting evanescent interference fringes laterally. Since the ratio of particle size to the interference pitch caused the difference in the intensity changes of scattering light, measuring the intensity changes can calculate the size of particle. Furthermore, by taking the advantage of the algorithm of contrast, this measurement can also be applied in high permittivity or absorptive particles as well.

Using the He-Ne laser (λ =633nm), evanescent interference field with pitch about 295nm is formed on prism. By introducing the Quarter-Half-Quarter wavelength plate (QHQ) phase shifter into one arm of interferometer, interference fringes can be shifted continuously. In Fig.1, the contrast detected by cooled CCD camera (BS-42 BITRAN) shows that the experimental results which are measured for polystyrene, gold and silica particles with radius from 20nm to 250nm are well agreed with theoretical value.

In this study, we propose a novel measurement of nano-particle size with a conventional optical microscope. By this low-cost measurement, particles with different material can be finely measured. In the further research, the measurement of object shape will be studied.

[1] M.Ohtsu; S. Kawata, Handbook of nearfield nano-photonics, Chapter 4. (Optronics,Tokyo, 1997)