Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Measurement of optical force in plasmonic resonant cavities using dynamic mode AFM DONGSHI GUAN, ZHIHONG HANG, Department of Physics, The Hong Kong University of Science and Technology (HKUST), ZSOLT MARCET, Department of Physics, University of Florida, HUI LIU, Department of Physics, Nanjing University, IVAN KRAVCHENKO, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, CHETING CHAN, HOBUN CHAN, PENGER TONG, Department of Physics, HKUST* — We report an experimental study of the optical force induced by a plasmonic resonance mode in metallic cavities using dynamic mode atomic force microscopy (AFM). The plasmonic cavity is made of a (upper) gold coated glass sphere and a (lower) quartz substrate patterned with an array of gold disks, whose diameter d varies from 250 to 750 nm. The gold coated sphere is glued to an AFM cantilever, by which we measure the optical force acted on the sphere using AFM and phase-sensitive lock-in amplifier. With this technique the sensitivity of the force measurement is significantly increased to $\sim$0.1 pN, which may have many applications in precise force measurement. The measured optical force is found to have a strong resonance dependence on the cavity separation r, as well as the diameter of gold disk d. The conventional optical force obtained in the far-field (r>3μm) for different values of d agrees well with the measured transmission. In the near-field (r<0.5μm), resonance is excited in the plasmonic cavity and the induced force by an infrared laser is found to be increased by an order of magnitude compared with the photon pressure generated by the same laser light.
*Work supported by the Research Grants Council of Hong Kong SAR.

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Date submitted: 05 Nov 2012 Electronic form version 1.4