Direct Measurement of Optical Force Induced by Near-Field Plasmonic Cavity Using Dynamic Mode AFM

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Plasmonic nanostructures have attracted much attention in recent years because of their potential applications in optical manipulation through near-field enhancement. Continuing experimental efforts have been made to develop accurate techniques to directly measure the near-field optical force induced by the plasmonic nanostructures in the visible frequency range. In this work, we report a new application of dynamic mode atomic force microscopy (DM-AFM) in the measurement of the enhanced optical force acting on a nano-structured plasmonic resonant cavity. The plasmonic cavity is made of an upper gold-coated glass sphere and a lower quartz substrate patterned with an array of subwavelength gold disks. In the near-field when the sphere is positioned close to the disk array, plasmonic resonance is excited in the cavity and the induced force by a 1550 nm infrared laser is found to be increased by an order of magnitude compared with the photon pressure generated by the same laser light. The experiment demonstrates that DM-AFM is a powerful tool for the study of light induced forces and their enhancement in plasmonic nanostructures.