The Key Structural Parameter for Off-resonance Enhancement of Infrared Absorption on Periodic Nanostructures

The key structural parameter for greater enhancement of infrared absorption on metal nanostructures was identified by systematic and exhaustive infrared absorption measurements for well-defined periodic gold square column (SC) arrays on silicon wafers. The SC arrays were fabricated using electron beam lithography. The crucial parameter determining the enhancement factor is the ratio of the separation distance to the square size. An electrostatic SC model calculation based on an off-resonant electromagnetic mechanism using the effective medium theory (EMT) shows good quantitative agreement with experimental observations of enhanced infrared absorption of adsorbed species. The clarified enhancement mechanism for infrared absorption of molecules adsorbed onto metal nanostructures is useful to elucidate applications such as designing SEIRA active substrates, analyzing reactions on electrodes, and detecting minute chemicals as highly sensitive chemical sensors and biosensors.