Effect of Polarization on the Electric Field Sensitivity of Optical Resonators

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Thesis Defense
Friday, April 27, 2012
Time: 1:30 PM
Location: Junkins 203

Abstract:

Electric fields have been shown to exert forces on both charged and uncharged dielectric objects. If these objects have relatively high dielectric properties, the electric field-induced force becomes even more significant and can add to the electric field sensitivity of the overall object. In this report, we investigate such an effect on the morphology dependent optical resonances, or MDR (also called the whispering gallery modes, WGM), of polymeric microspheres that are both pristine and doped with varying amounts of nanopowder materials, which include barium titanate, carbon black and calcium copper titanate. The doped microspheres have significantly higher dielectric constants than their pure polymeric counterparts. In the presence of an external electric field, a net charge will develop on the microsphere surface, contributing to the elastic deformation of the microsphere (strain effect). This effect is time-dependent and exhibits an exponential behavior (reaches an asymptotic value of deformation with a time constant unique to the sphere type). There is also an accompanying change in the refractive index (stress effect) of the polymeric-based material. Acting together, these changes induce a shift in the MDR (or WGM) of the microsphere.