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Design of Nano-Ears for Surface Enhanced Raman Scattering[1]
FERNANDO A. REBOREDO[2], CHAD E. TALLEY, STEPHEN M. LANE, Lawrence Livermore National Laboratory — Metallic structures optimized for surface enhanced Raman scattering (SERS) must combine i) large dipole moments, for stronger coupling with the external field E, and ii) highly localized plasmon modes, which increase Raman Scattering cross sections (proportional to E4) and improve spatial resolution. Since typical molecules are much smaller than the visible wave lengths, the design of nanostructured surfaces for SERS involves an electrodynamical problem analogous to the one solved with ear shapes in acoustics. In this limit, retardation effects can be ignored, which reduces the problem to the response at the metal surface. We have developed a finite element computational tool that allows the calculation of surface plasmons on arbitrary metallic shapes. We have found that an accurate description of the surface curvature is crucial. Our numerical results agree with exact analytical solutions for the quasi-static model known for spheres and spherical shells. Using this method, we have compared several shapes, where analytical results are not available, and uncover ear-shaped structures that are 12 orders of magnitude more efficient than spheres.

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