Nanoplasmonics and surface enhanced spectroscopy

Electron scattering enhancement by organic molecule in presence of metallic nanoshell

I.Yu.Goliney, Ye.V.Onykienko

Department of theoretical physics, Institute for Nuclear Research, Prospekt Nauki, 47, Kiev -03680, Ukraine.
E-mail: zhorzhonyk@gmail.com

The quantum-mechanical theory of inelastic electron scattering by a system consisting of a metallic nanoshell and an organic molecule is developed. It is shown that as the plasmons of a nanoshell may be studied by the method of electron energy loss spectroscopy (EELS) [1 – 2], the same method may be used for the study of the excitations of a molecule situated nearby.

The resonant enhancement of electron scattering by a molecule placed near the metallic nanoshell is due to the interaction of molecules with localized plasmons which possess very large dipole moments. As a result, the scattering of electrons by the molecule is enhanced by several orders of magnitude owing to the resonant mixing of the excited electronic state of the molecule with nanoshell plasmons' states and to the transfer of the oscillator strength to the molecule [3]. By varying the ratio of the inner and outer radii the nanoshell the plasmons' frequencies may be tuned in resonance with the molecular excitation.

The electron energy loss spectra dependence on the shell's outer radius, the relative position of the molecule and the shell, and the dipole moment of the molecule are presented. Of the two plasmon modes, the mode associated with the outer surface makes the main contribution to the enhancement of the molecule's excitation. It is shown that the probability of the molecular excitation by fast electrons grows so much that it becomes possible to observe individual molecule on the surface of the nanoshell in an electron microscope.

1. *U. Hohenester, Harald Ditlbacher, Joachim R. Krenn* Physical Review Letters — 2009, Vol. 103. — 106801.
2. *Garci'a de Abajo F. J.* Physical Review Letter — 2008. — 106804.
3. *I. Yu. Goliney, V. I. Sugakov, Yu. V. Kryuchenko* Physical Review B — 2005. —075442.