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Surface enhanced optical processes and regularities of their spectra in symmetrical molecules

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Surface enhanced optical processes SERS, SEHRS, SEIRA and single molecule SERS are of great interest. At present we have a reliable base in order to assert that their enhancement is associated with so-called strong quadrupole light-molecule interaction, arising in surface optical fields, arising near rough surfaces. The reason of appearance of these fields is a disordered medium where the characteristic size of the change of the electromagnetic field is equal to the characteristic length of the roughness. It appears that there is a strong enhancement of the electric fields and its derivatives in such a medium, especially near the places of substrate with a very large curvature. The second reason of the enhancement is an exclusive role of the quadrupole moments of the Q_{xx}, Q_{yy} and Q_{zz}, type, which are of a constant sign that results in a strong increase of their matrix elements with respect to the ones of the dipole moments d_i and quadrupole moments Q_{xy}, Q_{xz} and, $Q_{xz,}$ which are of a changeable sign. The increase of the number of moments, which are involved in the scattering results in appearance of forbidden lines in all the above processes. It appears and is confirmed experimentally that there are strong forbidden lines in symmetrical molecules with sufficiently high symmetry in SEIRA and SEHRS, which refer to the unit irreducible representation of the molecule symmetry group and the SERS lines, which refer to the vibrations with the irreducible representations describing transformational properties of the dipole moments. The last indicated lines are active in a usual IR absorption and are inactive in a usual Raman scattering. In addition the strong quadrupole light-molecule interaction experiences so-called electrodynamical forbiddance in molecules with cubic and icosahedral symmetry groups that results in the absence of the above mentioned lines in SERS, SEHRS and SEIRA spectra of molecules like methane, or fullerene C_{60}. Analysis of experimental SERS and SEIRA spectra of C_{60} strongly supports this result.

Biography

A M Polubotko has graduated from Physical Faculty of Leningrad State University in 1973. He has completed his PhD from Ioffe Institute, Russian Academy of Sciences and has been associated with the Azerbaijan Institute of Physics in Baku in 1983. Now he works as a Physicist Theorist and a Senior Scientific Researcher of Semiconductors and Dielectrics in the Department of Dielectrics and Semiconductors at Ioffe Physico-Technical Institute in Saint Petersburg. He has more than 120 scientific papers, preprints and abstracts published in reputed journals and reported on many Russian and International scientific conferences.

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