GENERAL SOLUTION FOR INTERFACE OPTICAL PHONON MODES IN A DOUBLE NANOSHELL SYSTEM

F.J. Clares[1], C. Kanyinda-Malu[1,2], and R.M. de la Cruz[1]

(1) Departamento de Física, EPS, Universidad Carlos III de Madrid, Av. de la Universidad 30, 28911 Leganés (Madrid), Spain.

(2) Departamento de Economía Financiera y Contabilidad II, FCJS, Universidad Rey Juan Carlos, Paseo de los Artilleros s/n, 28032 Madrid, Spain.

E-mail: rmc@fis.uc3m.es

The study of electron-phonon interactions in low-dimensional quantum structures have attracted much interest [1] since this interaction plays a key role in many physical processes, such as transport or electron relaxation processes in confined systems. Due to the rapid progress in semiconductor nanotechnology, sophisticated systems such as multi-layer planar CQWs, multi-layer coupling quantum well wire (CQWW) and multi-shell coupling quantum dots (CQDs) [2] can be fabricated. Along with devices fabrication, the works on phonon modes were extended to these new systems. In fact, recently a study on interface optical phonon modes in a double nanoshell system has been reported [3].

Thus, the aim of this work is to generalize the solution of the electrostatic potentials generated by the interface optical modes in a double nanoshell system which was obtained in our previous work [3]. For this, we use the dielectric continuum model. To illustrate our results, typical II-VI semiconductors are used as constitutive polar materials of the nanoshells. In figure 1, we show the scheme of the investigated system. Resolution of Laplace´s equation in bispherical coordinates for the general potentials derived from the interface vibration mode is made. By imposing the usual electrostatic boundary conditions at the surfaces of the two-nanoshell system, recursion relations for the coefficients appearing in the potentials are obtained, which entails infinite matrices. The problem of deriving the interface frequencies is reduced to the eigenvalue problem on infinite matrices. A truncating method for these matrices is used to obtain the interface phonon branches. As an example, in figure 2 we show the interface frequencies for CdS/ZnS/polyethylene as a function of the geometrical parameter D/R_1 and a fixed value of D/R_2. Clearly, we obtain a clustered band-like phonon modes, feature appearing in other low-dimensional heterostructures such as superlattices.

References:

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[2] Eychmüler, A.; Mews, A. and Weller, H., *Chem. Phys. Lett*. **208** (1993) 59.
[3] Kanyinda-Malu, C.; Clares, F.J. and de la Cruz, R.M., *Nanotechnology* **19** (2008) 285713.

Figures:

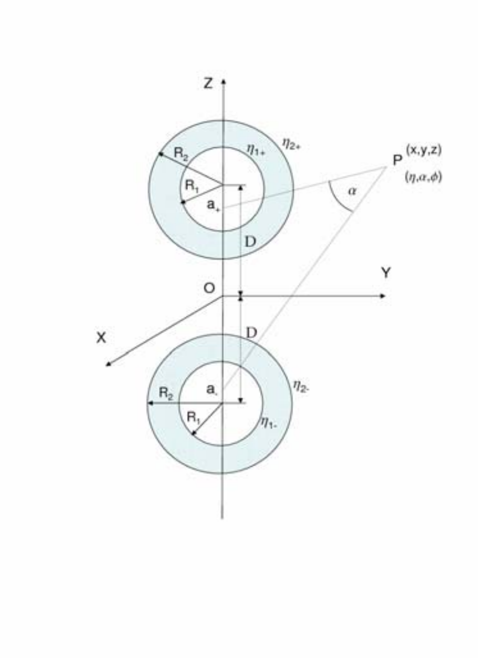

Figure 1: Scheme of the double coupled nanoshell system and the bispherical coordinates employed in the analysis with their respective parameters.

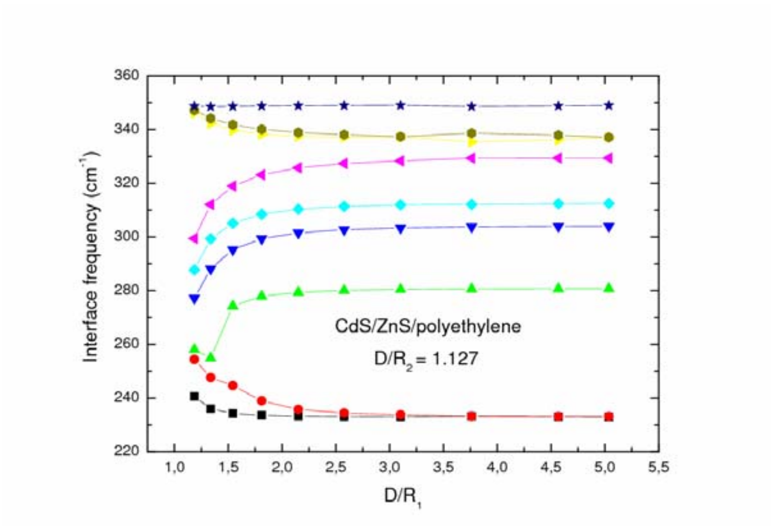

Figure 2: Interface frequencies of CdS/ZnS/polyethylene as a function of D/R_1.