Diffusion of Elastic Waves by an Atomic Well Implanted in a Thin Film Composed of Two Atomic Layers

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The increasing scientific interest during the last few years regarding the surface of nanomaterials comes from their richness and diversity that opened interesting prospects according to the fundamental conceptual point of view and the potential for applications in the field of the nanotechnology. From the point of view applications, it is a race on the miniaturization of the electronic devices and the density of the information storage that are the main concern of this research.

The growth of thin films causes defects of surface inducing a modification of the physical properties of such surfaces. Indeed, even when they are well prepared, crystalline surfaces present defects of structure, which is generally presented under the distribution of steps, varied heights, terraces, and wells. Moreover their vibrational study [1, 2] can lead to a better knowledge of their characteristics and thus constitutes a means of reliable processing control of the electronic components, mechanical, magnetic and optical.

In this study, we present the diffusion of elastic waves by an atomic well, established in a thin film composed of two infinite parallel atomic layers. The basic motivation is that the comprehension of its limitations that the structural disorder can induce on the physical properties of microelectronics mechanism.

The investigation of the waves of diffusion is carried out by solving directly the dynamic equations related to the atoms interacting with the first and second neighbours, within the framework of the harmonic approximation by using the model of the central forces.

Note that the method presented is derived from the work undertaken on electronic wave guides [3]. The matching method [4] is applied to the system considered in order to study the vibrational atoms, which constituted the well and the diffused modes by this well.

The theoretical calculations described in this work enable us to determine the transmission, reflection coefficients and the phononic conductance characteristic of the system, which is an accessible size experimentally. We study also the evolution of the spectra of transmission according to constants of force implied in the area of the defect.

The numerical results obtained show that the coefficients of transmission and reflection depend on the interferences between the waves diffused elastically by the defect. Moreover, the interaction between the states of diffusion and the states localised created by the defect show Fano's resonances similar to the electronic transport [5]. Let us note that these resonances are used for the construction of the filters of frequency and the transducers. So we have showed that the spectra obtained contain characteristic information of each defect.

References

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