POINT DEFECTS AND THE ($\sqrt{3}$x$\sqrt{3}$)⇔(3x3) SURFACE PHASE TRANSITION IN THE Pb/Ge(111) SYSTEM

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In this work we report on a thorough study of point defects in the 1/3ML-Pb/Ge(111) surface (α phase), performed by means of variable temperature scanning tunneling microscopy (VT-STM) in the 40K-300K temperature range. These point defects, which are mostly substitutional adatoms, are present in the family of systems formed by 1/3 ML Sn or Pb absorbed on Si(111) or Ge(111) surfaces within densities of 2-10%. Their role in temperature-dependent phase transitions that take place for such low dimensional systems have been widely discussed in the last few years[1]. For instance, point defects in the Sn/Ge(111) surface have been considered the driving force for the temperature-mediated ($\sqrt{3}$x$\sqrt{3}$)R30º ⇔ (3x3) phase transition taking place at low temperature. For that system, it has been reported that point defects realign during the structural phase transition from a random distribution onto a honeycomb lattice supporting the (3x3) phase [2,3]. However, a different behavior has been found for the apparently similar Pb/Si(111) system where it has been demostrated that substitutional point defects are immobile and they do not play any crucial role in the phase transition [4,5].

Concerning the Pb/Ge(111) system, it is well known that the α-phase exhibits a ($\sqrt{3}$x$\sqrt{3}$)R30º symmetry at RT which is lowered to a (3x3) periodicity at 110K [6]. However, the ground state for this system remains a controversial issue since a disordered phase was recently proposed for temperatures below 76K [7, 8]. It has been suggested that these phase transitions are accompanied by a realignment of point defects resulting in non-random distributions at low temperatures. In order to study the point defects mobility in the Pb/Ge(111) system we have recorded STM movies acquired by tracking defective regions while varying continuously the sample temperature from 40K to 300K. These real-time measurements provide an experimental evidence that point defects are not mobile throughout the above mentioned temperature range. Moreover, a statistical analysis has been performed by analyzing the Ge defects distribution from STM images at several temperatures. For the whole range of temperatures studied the point defects have been found to be randomly distributed even well below the transition temperatures. These findings are in clear contrast to previous assumptions for this system.

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Figures:

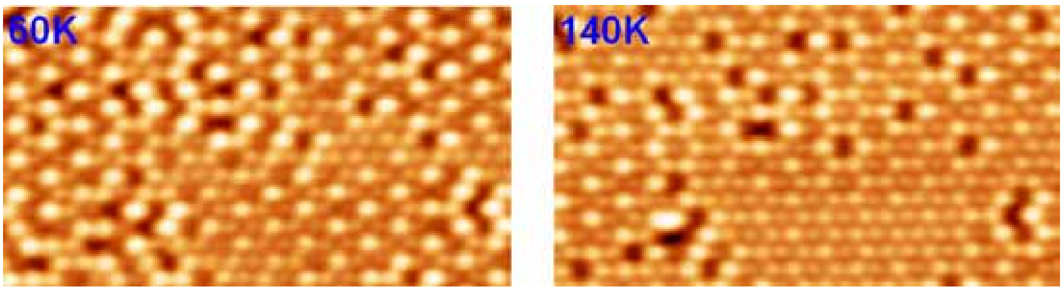

Figure 1: STM images of the same region (22x12 nm^2) extracted from a movie showing the immobility of defects in the 60K-140K interval of temperatures. Tunneling parameters for both images: Vs = -1.5 V; I = 0.1nA.