The Dynamic Role of Defects in Surface Phenomena

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The variable temperature scanning tunneling microscope is presenting an unprecedented view of the importance of defects in all forms of surface phenomena to the surface community. What is most surprising is that in many cases it is the dynamic behavior of the defects that is crucial. In this talk I will discuss several recently discovered examples illustrating that we need to take a fresh look at the dynamic role of defects at a surface or interface. The first example is associated with a complex symmetry lowering ($\sqrt{3}x\sqrt{3}$) to (3x3) phase transition in Sn/Ge(111). The study of macroscopic properties of phase transitions in low-dimensional systems provides an understanding of the fundamental aspects of systems of interacting particles. Phase transitions are strongly affected by defects, especially in systems with lower dimensionality. In quasi-1D or –2D systems that exhibit a CDW transition, a small proportion of microscopic disorder can control the global properties because of the collective nature of the phenomena. It has been speculated that the interaction of mobile defects with CDW leads to alignment of defects with the CDW, or the formation of Defect Density Waves.[1] In this dynamic picture, the distribution of defects is neither random nor static, instead defects align their positions to optimize the energy of the pinned CDW. Here, in this system and similar systems the transition can be decomposed into two intertwined phase transitions: a second order CDW transition and a first order disorder-order transition in the defect distribution.[2,3] The second example is the observation of an incommensurate Defect Density Wave in the Sn/Si(111) system.[4] Finally I will end with the beautiful work of the Salmeron group on the role of subsurface impurities in Pd(111).[5] These mobile impurities interact with adsorbed atoms and molecules, limiting surface diffusion, nucleating island growth, and serving as active sites for surface reactions.

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