An atomic view of the role of defects in 2D phase transitions

E. W. Plummer, University of Tennessee, DMR 9801830

Defects play a prominent role in reduced dimensional phase transitions. This influence on an atomic level can be observed using Scanning Tunneling Microscope (STM) in materials that display a phase transition to a Charge Density Wave (CDW) state . Defects by affecting electronic structure in their vicinity produce their own modulation of charge – defect-induced CDW. The induced CDW in turn exerts a force on the defects. If defects are sufficiently mobile they move under influence of this force and align with the CDW. This ordering of defects is called Defect Density Waves (DDW).

Interaction of defects with CDW was observed in ulta-thin metal films of Sn and Pb on Ge(111). Recently, we have observed 1D DDW in Sn/Si(111) (figure on the right)* .

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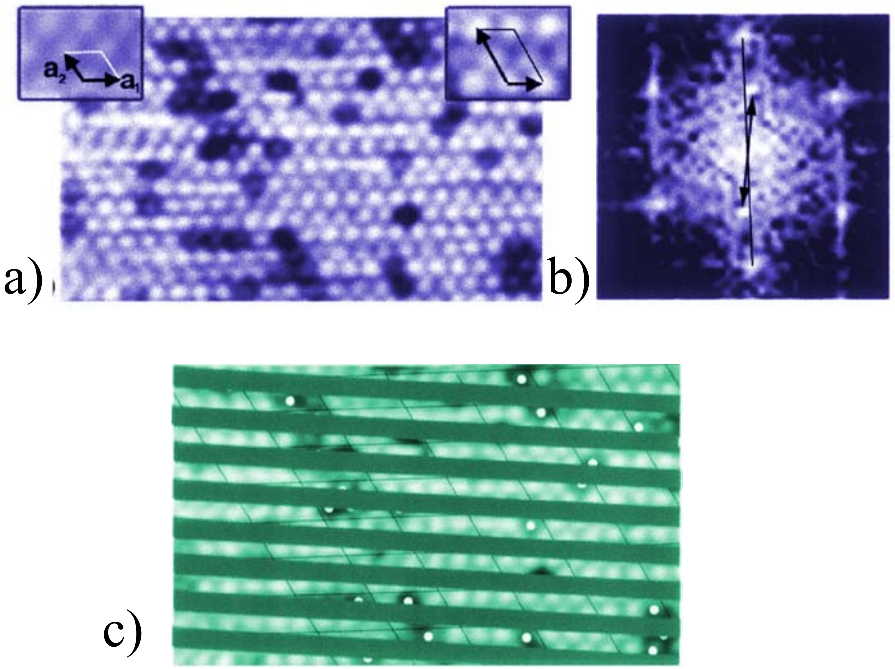
Graduate students: Anatoli V. Melechko (UTK)

Post-docs: Jens Braun (UTK)

Collaborators: Luca Ottaviano (INFM, Italy), Hanno H. Weitering (UTK)



Defect Density Wave

An STM image of Sn/Si(111) surface. (a) The dark spots are point defects- Si substitutional atoms. The brightness of atomic rows is periodically modulated incommensurate with the periodicity of the lattice as shown in Fourier transform of the STM image (b). The incommensurate periodicity is indicated by arrows. The modulation of brightness of STM image is due to formation of incommensurate 1D CDW. Interaction of defects with this wave causes the periodic modulation of defect density – DDW. The DDW is illustrated in c) where ¾ of all defects in a) can be covered by stripes that cover darker half period of the CDW.