MAR11-2010-020114

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

GMAG Student Dissertation Award Talk: Effects of Nanoscale Structure on the Magnetism and Transport Properties of Chromium and Chromium-Aluminum Alloys[1]

ZOE BOEKELHEIDE, University of California, Berkeley

Bulk Cr has an incommensurate spin density wave (ISDW) due to nesting of the Fermi surface which is easily disrupted by perturbation. Thus, the properties of Cr are sensitive to small amounts of dopant atoms, application of pressure, etc. which has been well studied in bulk. We have taken advantage of thin film growth techniques to study the effects of nanoscale structure on the properties of Cr and Cr1-xAlx alloys. The first part of my talk will discuss our research on polycrystalline Cr thin films, where variables such as strain and disorder crucially affect the SDW. We find that Cr thin films can be ISDW like in bulk Cr, or transition to commensurate SDW (CSDW) or mixed depending on deposition conditions and the resulting thin film microstructure. The transport properties are also strongly affected, as quasilocal defect states inside the SDW gap cause resonant scattering. This results in anomalous features such as residual resistivity ranging between 3 and 400 μO -cm and significant resistivity minima at low temperature. Further evidence of quasilocal states inside the SDW gap is seen in the enhanced electronic density of states (DOS) from specific heat measurements of Cr thin films. The second part of my talk will discuss Cr1-xAlx alloys. The addition of Al to Cr causes the ISDW to transition to CSDW for x = 0.03. Cr1-xAlx also exhibits previously unexplained semiconducting behavior for x = 0.15-0.30. I will discuss our ongoing theoretical and experimental research which suggests that a chemically ordered, rhombohedrally distorted Cr3Al structure occurs in nanosized domains and causes a hybridization gap on part of the Fermi surface. The CSDW causes a gap on another part of the Fermi surface, so that the semiconducting behavior can be explained by a combination of structural and magnetic affects.

[1]Supported by the DOE under Contract No. DE-AC02-05CH11231.