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Phase Transitions and Fluctuations in Nanoconfined Systems Recent Insights from Synchrotron Radiation Studies

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Binary alloys are very efficient model systems to study cooperative phenomena in condensed matter, they also play an important role as structural materials in current and future technologies. One future challenge is to understand on a microscopic level, how the phase behaviour and thermal, mechanical, and magnetic properties of binary alloys are altered in nanoconfinement geometries. Key to this understanding are the various types of thermally excited clustering and ordering fluctuations, which are dressed by a long-ranged strain field (caused by the size mismatch of the two alloy constituents). These fluctuations given raise the well-known short range order (SRO) diffuse scattering.

In this lecture I show how the premier properties of Synchrotron radiation can be exploited to get a detailed insight into the ordering phenomena in nanoconfined alloys. I present several novel experimental schemes including phase-sensitive x-ray diffraction from thin epitaxial alloy films, (SRO) diffuse scattering exploiting high-energy x-rays and time-resolved x-ray microbeam diffraction to access microscopic order fluctuations in the time domain.

I will discuss the influence of surfaces and interfaces and of confinement onto order-disorder transitions in FeCo thin films /1,2/. The subtle interplay of competing fluctuations and how this affects the alloy phase behaviour of thin films is demonstrated in the case of Au Ni alloys /3/ which have been a mystery over the last 20 years. Finally, the temporal nature of order fluctuations is explored by x-ray intensity correlations spectroscopy at FeAl alloys close to the critical B2-A2 order-disorder transition which gives a first insight into scaling in the time domain /4/.

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