# Vibrational Properties of Thin Fims and Interfaces

KEUNE W.
Institut für Physik, Universität Duisburg-Essen, D-47048 Duisburg, Germany

In the past, extensive Raman investigations of phonons in semiconducting epitaxial nanoscaled multilayers (superlattices) revealed novel phonomena, such as folding of phonon dispersion relations, phonon confinement, and vibrational interface states [1]. For *metallic* multilayers, on the other hand, only few literature reports on folded [2] or confined [3] phonons exist.

$^{57}$Fe nuclear resonant inelastic X-ray scattering (NRIXS) provides a means for measuring the projected phonon density of states (DOS), g(E), of $^{57}$Fe-containing thin films, multilayers and interfaces [4]. We have applied NRIXS to nanoscaled metallic multilayer systems and thin films in combination with the $^{57}$Fe probe layer technique, allowing the measurement of g(E) at selected depths (e.g. at interfaces or in the film center). Experimental results are presented for $^{57}$Fe/Cr [5] and $^{57}$Fe/Pd nanoscaled superlattices, and also for seminconducting β-$FeSi_2$ thin films. For ~15Å Fe the high-energy phonon peak in the Fe-DOS is strongly suppressed in Fe/Pd (but *not* in Fe/Cr), very likely due to confinement. Remarkable changes in the Fe-DOS of Fe/Cr are observed at buried interfaces and with decreasing Fe film thickness as a result of a crossover from 3D to 2D behavior and alloying. Peak positions observed in the Fe-projected DOS of β-$FeSi_2$ films agree well with peaks in Raman and infrared spectra reported in the literature.

**References**

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