Proximity effect of vanadium on spin-density wave magnetism in Cr/V bilayers

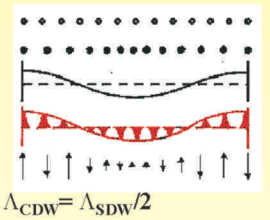
E. Kravtsov[a], B. Hjörvarsson[b], A. Hoser[c], A. Nefedov[a], F. Radu[a], A. Remhof[a], S.B. Wilkins[d] H. Zabel[a]

[a] *Institut für Experimentalphysik/Festkörperphysik Ruhr-Universität, Bochum, Germany*
[b] *Department of Physics, Uppsala University, Sweden*
[c] *Institut für Kristallographie, RWTH-Aachen, Germany*
[d] *European Synchrotron Radiation Facility, Grenoble, France*

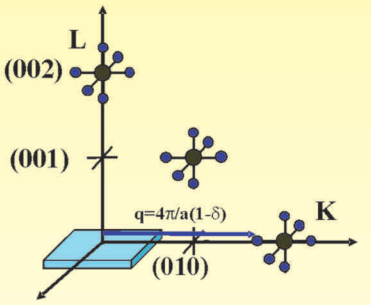
Introduction

Bulk Cr is an itinerant antiferromagnet displaying an incommensurate spin density wave (SDW) below T_N=311K. The SDW is accompanied by periodical modulations of the lattice spacing - strain wave (SW) and by the charge density wave (CDW) that can be effectively investigated with high-resolution X-ray diffraction. SW and CDW give rise to satellite reflections arising around fundamental Bragg peaks.

It should be noted that whereas the DSW behaviour in bulk Cr is well established, there are significant gaps in our understanding of magnetism in thin Cr layers contacting with layers of other metals. Cr/V is a system in which the SDW state is expected to be under strong influence of proximity effects. We studied effect of very thin vanadium layer on SDW state in thick Cr film.



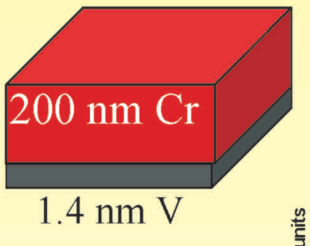
$\Lambda_{CDW} = \Lambda_{SDW}/2$

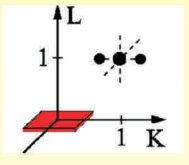


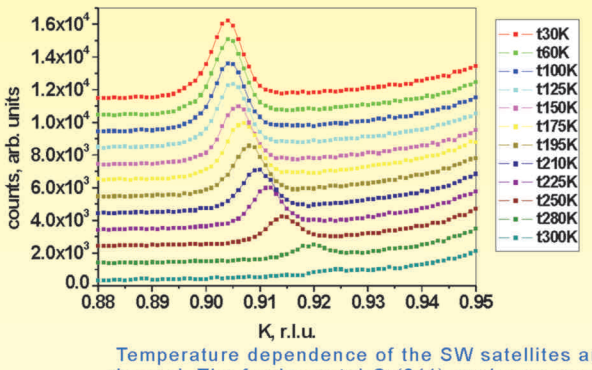
$$\left(\frac{d\sigma}{d\Omega}\right)_{x-ray} = \frac{1}{4}\left|\rho_0(\vec{K})\vec{K}\cdot\vec{\Delta} \pm \sigma\right|^2 \delta(\vec{K} \pm 2\vec{Q} - \vec{G})$$

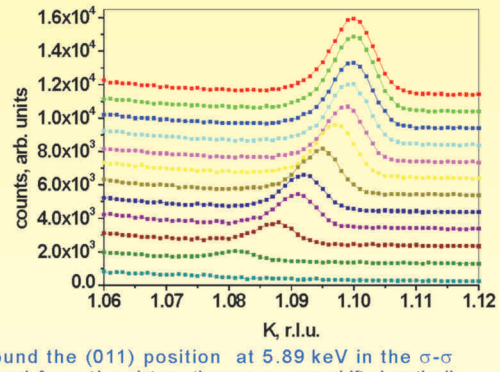
$$2Q = \frac{4\pi}{a_{Cr}}(1-\delta) = \frac{4\pi}{a_{Cr}} - \frac{4\pi}{\Lambda_{SDW}}, \Lambda_{CDW} = a/(2\delta)$$

Experimental results: Cr(2000A)/V(14A) film

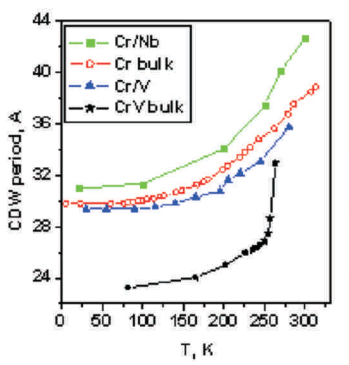


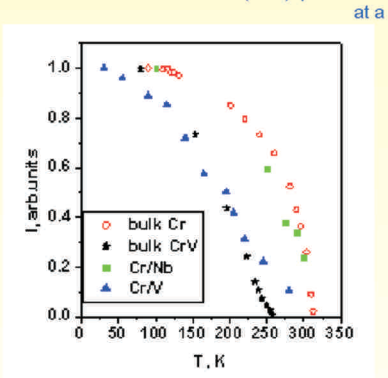






Temperature dependence of the SW satellites around the (011) position at 5.89 keV in the σ-σ channel. The fundamental Cr(011) peak was removed from the picture, the curves were shifted vertically at a constant value.





The SW period and the SW satellite intensity as functionы of temperature in our Cr/V system, Cr/Nb system and in bulk Cr and CrV alloy.

Conclusions

- We investigated SDW state Cr/V films. The influence of Cr/V interfaces was shown to be not restricted by local effects but determine basic SDW parameters.

- The system displays qualitative features that are characteristic of bulk CrV alloys with low concentration of V:

1. The SW period decreases as compared with bulk Cr. This is a typical feature of bulk CrV alloys only and so far it has been never observed in Cr thin film systems.
2. The mechanism of the temperature supression of the SDW state is different from that of bulk Cr and other Cr thin film systems.

a) The SW order parameter depends on temperature in a quasilinear way. Such behaviour is typical of some CrV alloys but not for bulk Cr and other Cr-based thin film systems.

b) The SW correlation length in our system is essentially temperature independent. In bulk Cr this length decreases with temperature.