ESRF	**Experiment title:** Surface Induced Order at $Cu_{1-x}Pd_x(001)$ Surfaces	**Experiment number**: SI 663
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Report:

In previous experiments we have detected extraordinary stable surface induced order (SIO) for the alloy $Cu_3Pd(001)$: while the bulk order-disorder transition temperature is T_B=730 K a thin surface layer remains laterally ordered up to temperatures as high as T_S=1210 K [1]. Since it was clearly demonstrated [2] that a $Cu_{83}Pd_{17}(001)$ sample exhibits surface induced disorder (SID), the Cu-Pd system provides the unique possibility to study the transition from SID to SIO as a function of the concentration.

The sample investigated here was a $Cu_{80}Pd_{20}(001)$ single crystal mounted in a mobile UHV-chamber, in a horizontal sample geometry. The polished sample surface was prepared for surface experiments by cycles of Ar sputtering and annealing. The absence of any contaminants on the surface was checked by Auger electron spectroscopy, and the chemical composition of the sample by microbeam analysis.

The diffraction experiments were performed at 17 keV energy (0.7225 ≈ wavelength) in a grazing incidence geometry. **Figure 1** shows the measured (background corrected and integrated) intensity of the in-plane (100) superstructure peak, characteristic for the order of the surface in a temperature range close to the bulk transition temperature (T_B=755 K). SIO is evidenced up to $T_S=T_B$+10 K. The following table summarizes the main characteristics of the surface phase transformations in CuPd alloys:

Sample	T_B(K)	T_S(K)	T_S/T_B	Remarks
$Cu_{83}Pd_{17}$	778	-	-	SID [2]
$Cu_{80}Pd_{20}$	755	765	1.011	SIO (this work)
$Cu_{75}Pd_{25}$	730	1210	1.658	SIO [1]

During the diffraction experiments, the (20L) (fundamental) and (10L) (superstructure) crystal truncation rods were measured at different temperatures. The measurement of the (20L) rods allows to extract the composition profile normal to the surface, as described in [3]. The deep dip appearing at the anti-Bragg position for $T>T_B$ is attributed to an oscillatory composition profile, starting with a Cu-rich layer in the surface (Cu segregation) and damping with a decay length of some tens of atomic layers. The apparent oscillations for lower temperatures can be explained by the presence of buried antiphase domain boundaries in the composition profile; detailed modelling of the intensity distribution along the rod will allow to model their characteristics and formation.

Two (10L) rods (measured at T = T_B+0.2 K and T_B+5 K) are shown in **Figure 3**. The peaks (L=0,1,2,Ö) on the superstructure rod are split normal to the surface; this splitting is not due to the short range order but shows the presence of antiphasing in the ordered near-surface region. Fitting the measured intensity along the rod gives access to the thickness of the lateral ordered layer. Note here, that the in-plane width of the superstructure rod is very small indicating a long-range coherent ordering up to 1000 ≈.

The obtained result for this particular concentration shows that the Cu-Pd system is indeed most suitable for the study of the transition from SID to SIO as a function of concentration for binary metallic alloys (see table above). Thereby, our measurements elucidate for the first time the role of the surface field h_1 and modified surface interaction parameters onto the nature of surface phase transformation. Further studies ($Cu_{1-x}Pd_x$ samples with concentration in the 0.15<x<0.3 range) are mandatory.

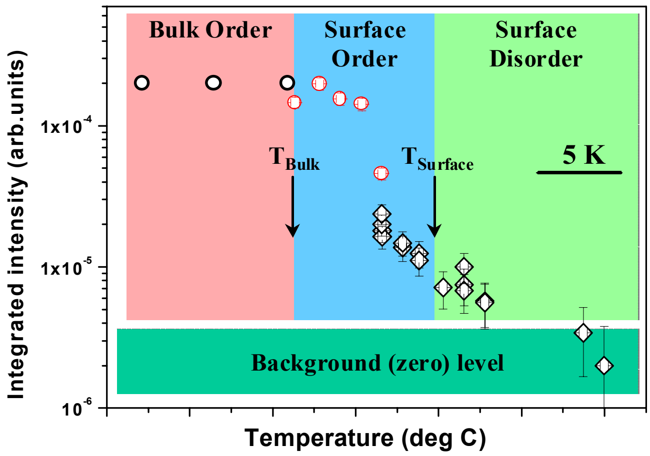

Figure 1: Integrated intensity of the (1,0,0.02) surface peak (incidence angle 0.18°), showing the presence of the SIO. In the bulk order region (3 points), the (100) was not measured, the order was evidenced by the increase in intensity of the superstructure (101) peak with the incidence angle.

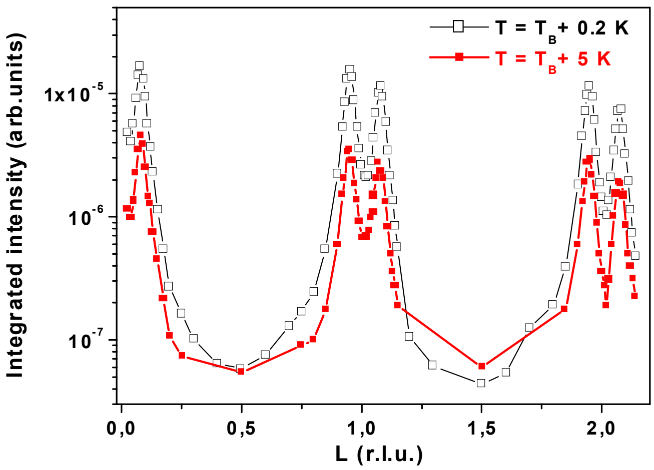

Figure 3: (10L) rods measured at two temperatures (see legend). With increasing the temperature, the general shape is conserved, only the relative intensities are modified.

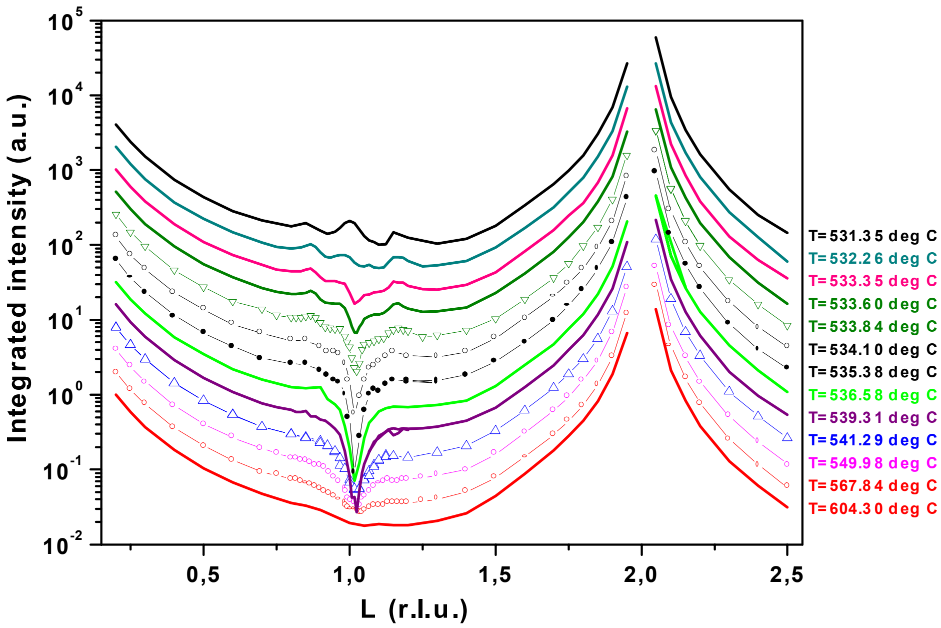

Figure 2: (20L) rods measured in the T_B to T_B + 73 K (surface order and surface disorder) range. The temperatures are reported on each curve.

[1] H.Reichert, S.Engemann, H.Dosch, H.Hong, Z.Wu, H.Chen, in preparation.
[2] L.Barbier *et al*, Phys.Rev.Lett. **78** 3003 (1997).
[3] H.Reichert, P.J.Eng, H.Dosch, I.K.Robinson, Phys.Rev.Lett. **74** 2006 (1995).