	Experiment title: Spectroscopic study of vanadium induced interlayer disorder in $CuCr_{1-x}V_xS_2$ layered structure	**Experiment number**: MA-1768
Beamline: ID12	**Date of experiment**: from: 30.04.2013 to: 06.05.2013	**Date of report**: 26.02.2014
Shifts: 18	**Local contact(s)**: ROGALEV Andrei	*Received at ESRF:*

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Report:

Inorganic compounds with nearly two-dimensional crystal structure attract the great attention in both academic and industrial communities. Among these materials are, for example, high T_c superconductors such as Cu oxides systems or high performance thermoelectric materials like Na_xCoO_2 and Ca-Co-O systems. In this viewpoint $CuCrS_2$ is also an interesting system. This compound is composed of CrS_2 layers sandwiched by Cu ion layers. It was revealed that Cu ions show high ionic conductivity, which implies that they are not strongly bounded with the sulphur atoms and the CrS_2 layers are electronically separated [1]. Temperature of transition to this superionic state can be reduced by doping of vanadium atoms. $CuCrS_2$ shows a long-range antiferromagnetic ordering at T_N=39 K, which is found to be suppressed quickly by the V substitution. Above x=0.2 in $CuCr_{1-x}V_xS_2$, the ordered state is

replaced by a spin glass behaviour [2]. The combination of the electronic properties observed in $CuCrS_2$ makes it a potential candidate for various thermoelectric applications [3].

$CuCr_{1-x}V_xS_2$ samples (x=0, 0.05, 0.10, 0.12, 0.13, 0.15, 0.20, 0.30 and 0.4) were synthesized using solid state reaction and characterized previously by X-ray diffraction and X-ray photoelectron spectroscopy [8]. During the MA-1768 experiment at the ID12 beamline, the Cr, V and S K-edge XANES spectra in $CuCr_{1-x}V_xS_2$ samples have been collected in the fluorescence mode in backscattering geometry. Three types of samples were studied: powder samples, composites prepared by crystal growth from melts and monocrystals grown by the chemical transport reaction method. Figure 1 shows the experimental spectra of the V and Cr K-edge in $CuCr_{1-x}V_xS_2$ samples with a different concentration of the doping atoms (x=0.05, 0.1, 0.12, 0.13).

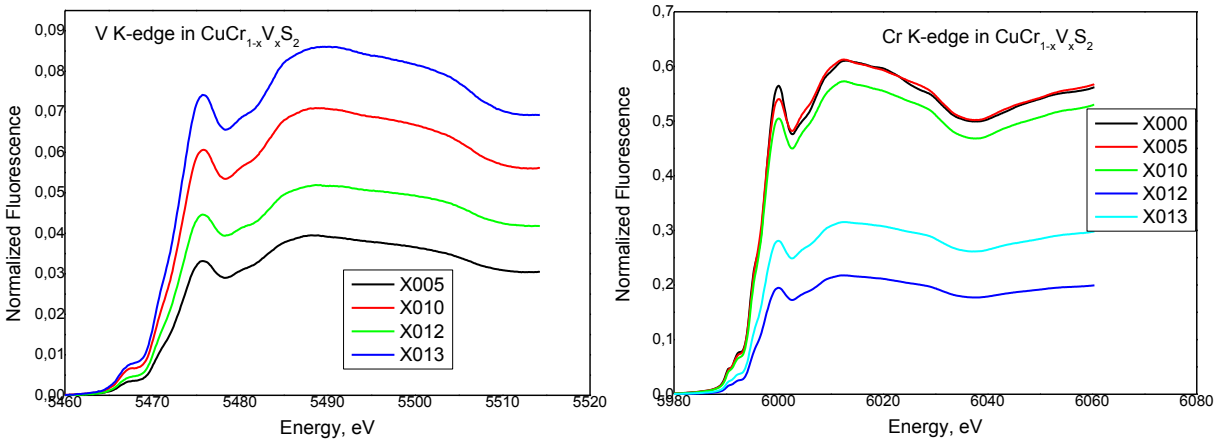

Figure 1. The experimental spectra of the V and Cr K-edges in $CuCr_{1-x}V_xS_2$ samples with a different concentration of the doping atoms (x=0.05, 0.1, 0.12, 0.13).

The Figure 2 presents the experimental S K-edge spectra in $CuCr_{1-x}V_xS_2$ samples with concentration of the doping atoms x=0.05, 0.1, 0.13 (left panel) and the S K-edge X-ray Linear Dichroism (XLD) spectra in the $CuCrS_2$ monocrystal grown by the chemical transport reaction method (right panel).

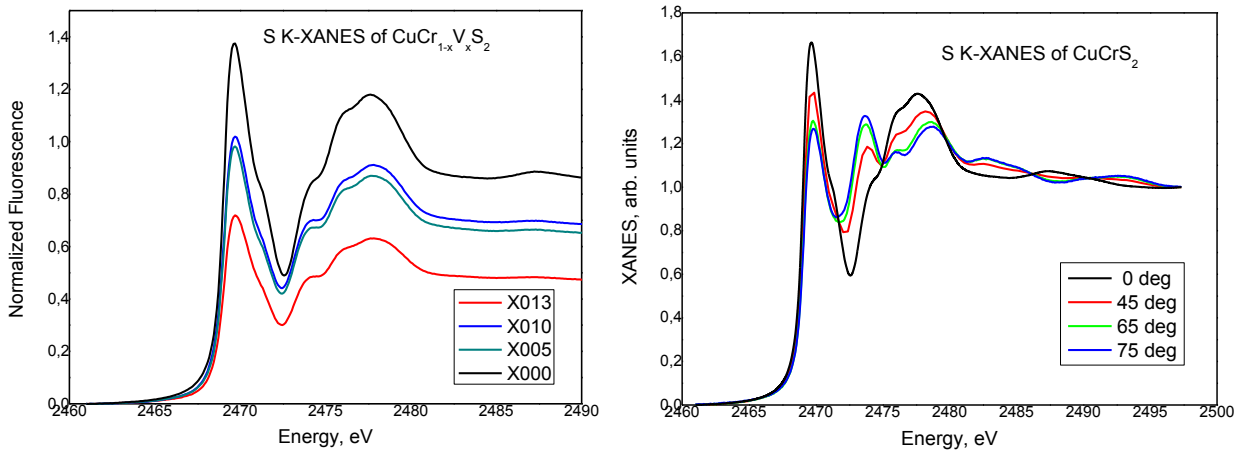

Figure 2. The experimental spectra of the S K-edge spectra in $CuCr_{1-x}V_xS_2$ samples with concentration of the doping atoms x=0.05, 0.1, 0.13 (left panel) and XLD spectra in the $CuCrS_2$ monocrystal (right panel).

The XLD spectra clearly show the difference between the XANES spectra for two perpendicular directions of the linearly polarized x-ray light. This difference reflects the anisotropy of the unoccupied electronic density of states of the 3p shell projected perpendicular and parallel axis.

The XMCD spectra at the Cr K-edge in $CuCr_{0.4}V_{0.6}S_2$ sample have been measured (Figure 3). The experimental conditions were T=6 K and applied field H= ±17 T. The magnetic field was parallel to the incident beam and the incident angle was zero (normal incidence). The XMCD signal was obtained by a direct difference of the XANES spectra recorded with opposite helicities for both orientations of the fixed magnetic field.

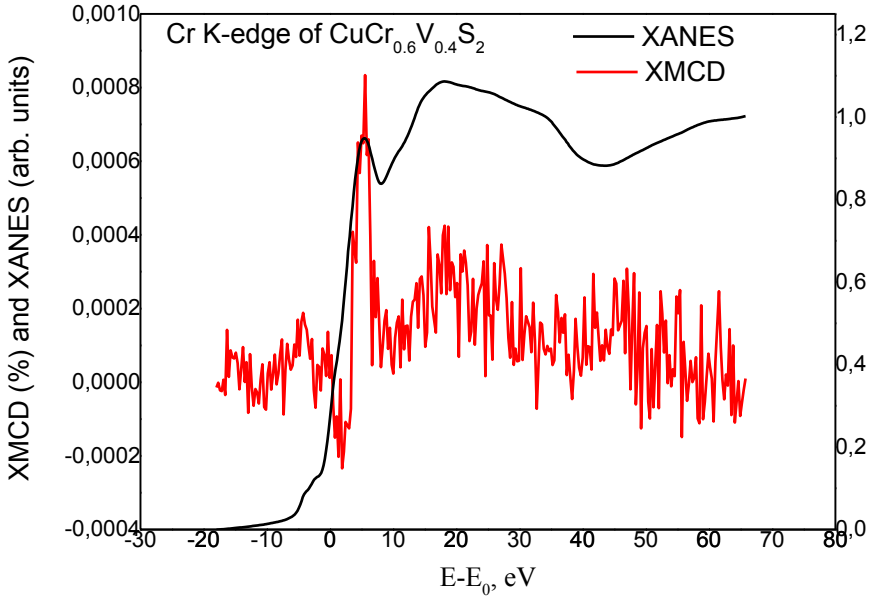

Figure 3. The XMCD spectra at the Cr K-edge in $CuCr_{0.4}V_{0.6}S_2$ sample.

Our experiment have shown a presence of the magnetic moment on the Cr atoms for the consentration of vanadium dopants 40 % and prove the hypothesis about a disappearance of the antiferromagnetic ordering for $CuCr_{1-x}V_xS_2$ samples with large doping concentration. Studing of the magnetic moment on the vanadium dopants is the subject for a future reseach.

References

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