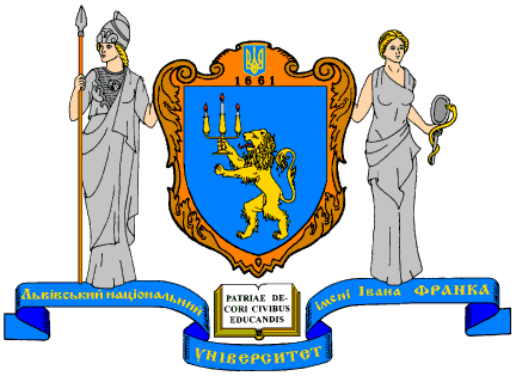

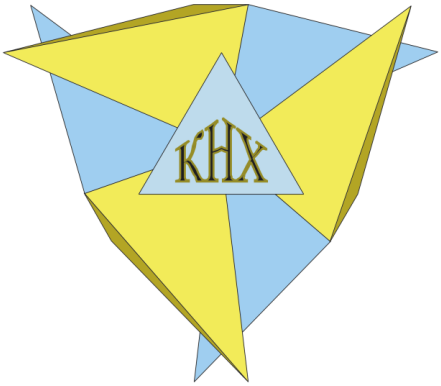

EFFECT OF SUBSTITUTIONS ON MAGNETISM OF $NdCo_{4.5}(Al, Li)_x$

I. Stetskiv[1,2], V. Kordan[1], I. Tarasiuk[1], H. Michor[2], V. Pavlyuk[1,3], E. Bauer[2]

[1] Department of Inorganic Chemistry,
Ivan Franko National University of Lviv,
Kyryla i Mefodiya St., 6, 79005 Lviv, Ukraine
[2] Institute of Solid State Physics, Vienna University of Technology,
Wiedner Hauptstraße 8-10, A-1040 Vienna, Austria
[3]Institute of Chemistry, Jan Dlugosz University in Czestochowa,
al. Armii Krajowej 13/15, 42-200 Czestochowa, Poland

XXII International Seminar on Physics and Chemistry of Solids (eISPCS'20)
June 17–19, Lviv, Ukraine

Rare-earth (R)–3*d* transition metal (T) intermetallic compounds, with a hexagonal $CaCu_5$ structure, are actively studied from both fundamental and technological points of view. It was previously reported, that $NdCo_5$ compound is known for its ferromagnetic, strongly anisotropic behavior. Easy direction reorientation from *c*-axis to the basis plane is observed while cooling down. The spin reorientation (SR) occurs gradually between 230 and 290 K [1]. Aluminum doping affects anisotropy constant values, they decrease with increasing Al composition. High value of Curie temperature of binary compound decreases several times after doping [2].

It is of interest to see what impact on magnetic properties the substitution of cobalt with aluminum and lithium has. $NdCo_5$, $NdCo_{4.5}Al_{0.4}Li_{0.1}$ and $NdCo_{4.5}Al_{0.3}Li_{0.2}$ samples were prepared by arc melting of pure components on a water-cooled copper hearth in purified argon atmosphere. X-ray powder diffraction patterns (Fig. 1) were obtained using Panalytical X'Pert Pro MPD diffractometer (Cu Kα-radiation). Phase composition and cell parameters of samples were determined by X-ray powder diffraction and energy dispersive X-ray spectroscopy (Tescan Vega 3 LMU).

[1] H. Bartholin, B. van Laar, R. Lemaire et al., J. Phys. Chem. Solids 27(8) (1966) 1287-1293.

[2] K. Konno, H. Ido, S. F. Cheng et al., J. Appl. Phys. 73 (1993) 5929-5931.

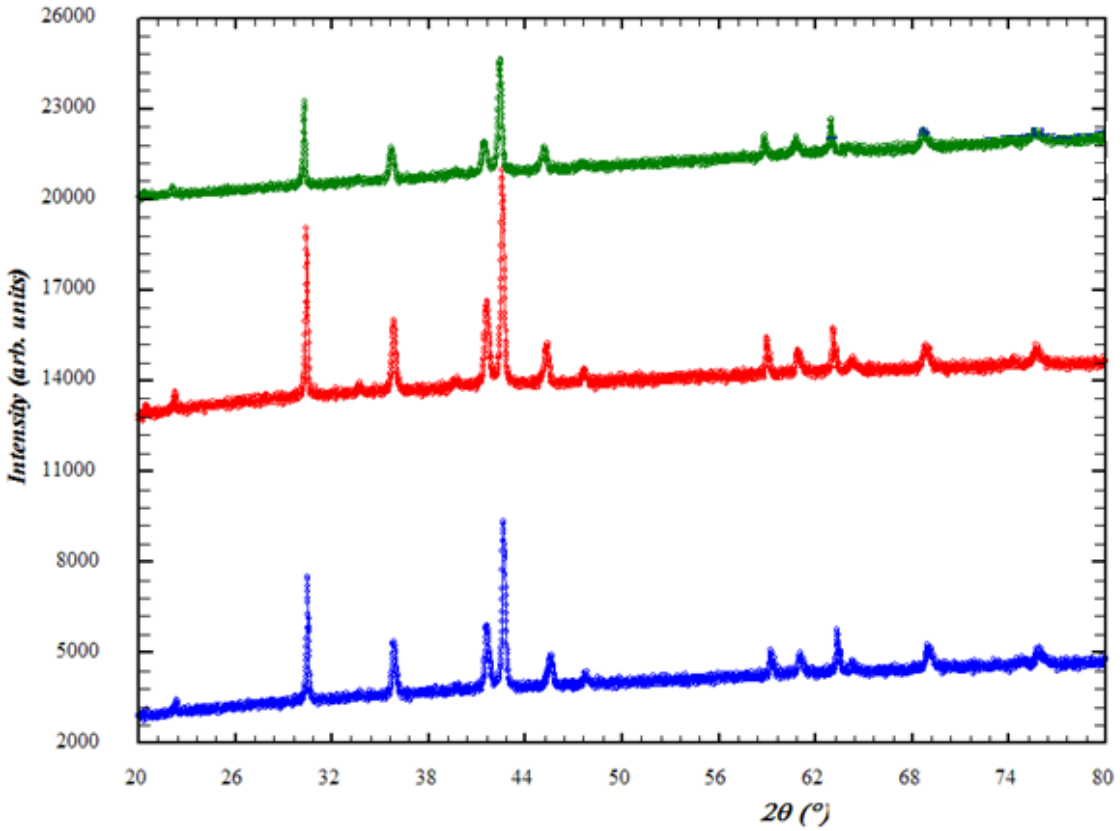

Figure 1. X-ray diffraction patterns of the $NdCo_5$ (blue), $NdCo_{4.5}Al_{0.4}Li_{0.1}$ (red) and $NdCo_{4.5}Al_{0.3}Li_{0.2}$ (green) samples

X-ray phase analysis of all investigated alloys showed the formation of a main phase with $CaCu_5$-type structure (space group *P*6/*mmm*, Pearson symbol *hP*6) and minor amounts of a phase with $PuNi_3$-type structure (space group *R*-3*m*, Pearson symbol *hR*36). The cell parameters and volume increase with increase of lithium amount in the alloy and are presented in Table.

	a, Å	*c*, Å	*V*, Å^3
$NdCo_5$	5.0089(5)	3.9783(6)	86.44(2)
$NdCo_{4.5}Al_{0.4}Li_{0.1}$	5.0160(8)	4.0011(9)	87.18(3)
$NdCo_{4.5}Al_{0.3}Li_{0.2}$	5.0246(5)	4.0048(6)	87.56(2)

Table. Cell and volume parameters of investigated phases.

For the measurements of physical properties samples were cut at Struers Accutom-100 cut-off machine. For resistivity measurements, four wires were connected between each sample and universal sample holder board; the outer two wires apply currents to the sample, and the inner two wires measure the voltage drop. To mount a sample on a universal sample holder board, we secured the sample to the sample holder board, and then wired the sample to the sample holder board. Electrical connections to the mounted sample were made through contact pads on the sample holder board.

The electrical resistivity down to 4 K was measured employing an A.C. measuring technique. The electrical resistivity of samples (Fig. 2) increases with increase of the alkali metal amount in the alloy.

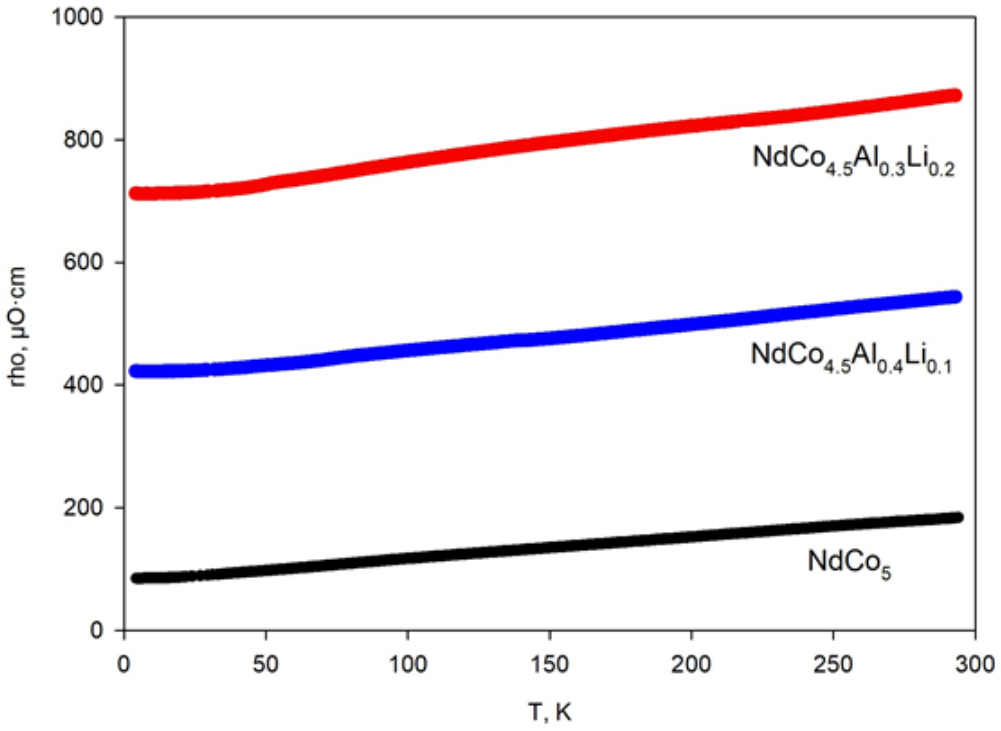

Figure 2. Electrical resistivity of the $NdCo_5$ (black), $NdCo_{4.5}Al_{0.4}Li_{0.1}$ (blue) and $NdCo_{4.5}Al_{0.3}Li_{0.2}$ (red) samples

Bulk polycrystalline samples were studied in a vibrating-sample magnetometer in magnetic fields up to 9 T at 5 K (Fig. 3a) and in magnetic field range from 0.1 to 3 T (Fig. 3b–d) in temperature range from 3 to 400 K. Aluminum and lithium substitution does not affect

substantially the value of the saturation magnetization (~8μ_B/f.u. at 9 T), but the increase of lithium content leads to faster saturation. The SR transition cone has less pronounced maximum in magnetic field of 3 T compared with 0.1 and 1 T results. At smaller magnetic fields Al and Li doped samples have higher values of T_{SR1}, but T_{SR2} is approximately equal for doped and binary samples and smaller cone may suggest weaker anisotropy for substituted compounds.

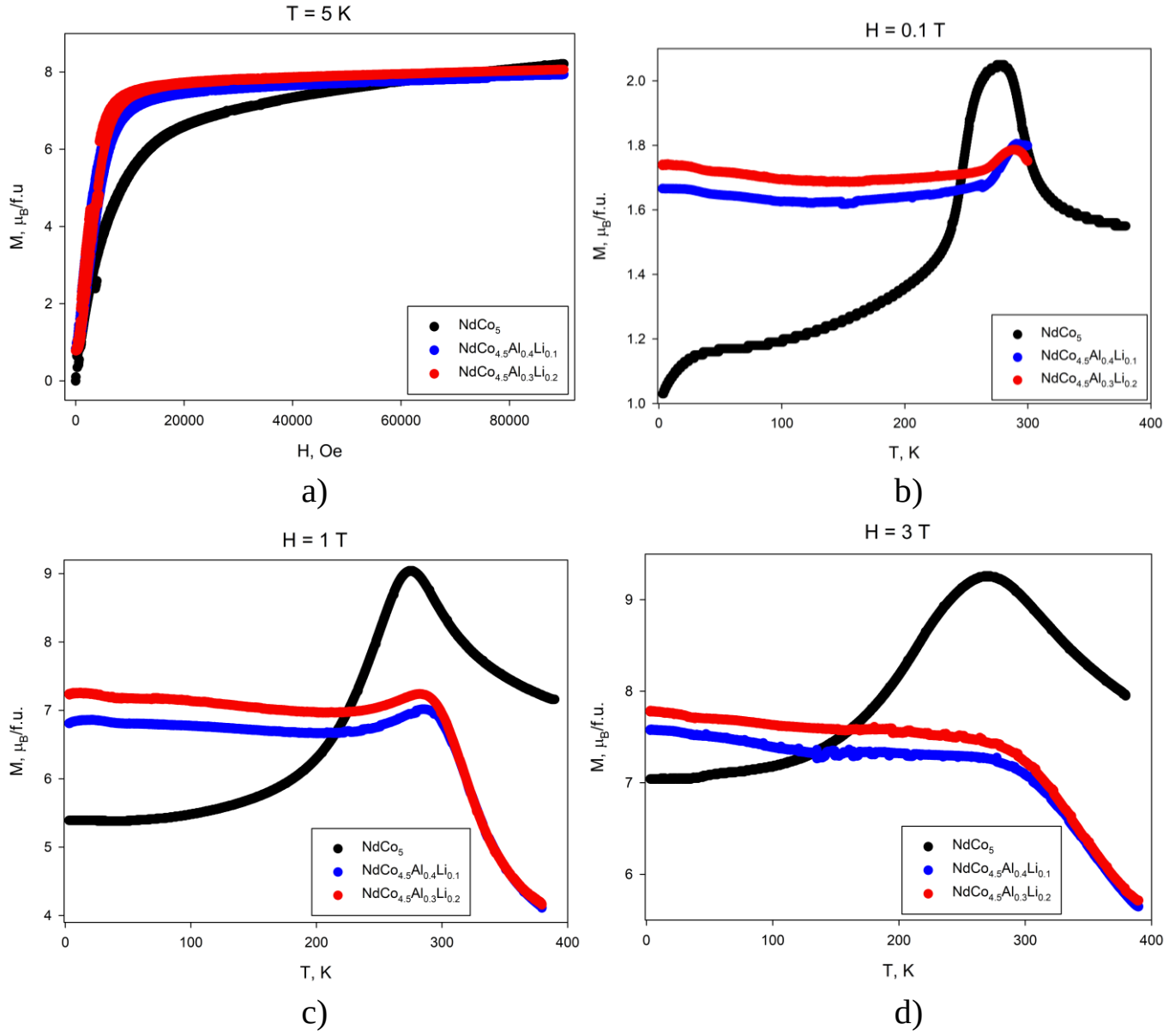

Figure 3. Magnetization versus a) applied magnetic field at T = 5 K; temperature at b) H = 0.1 T; c) H = 1 T; d) H = 3 T.

This work was supported by ICM-2019-13456 Scholarship of the Scholarship Foundation of the Republic of Austria for Undergraduates, Graduates, Postgraduates funded by OeAD-GmbH on behalf of and financed by the Scholarship Foundation of the Republic of Austria.