ESRF	**Experiment title:** Russian Grant Proposal: **Microscopic origin of hard magnetic phases in nanostructured magnetic materials revealed by XMCD**	**Experiment number:** MA-3314
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Names and affiliations of applicants (*indicates experimentalists)

Alexey Menushenkov – NRNU MEPhI (apmenushenkov@mephi.ru)

Valentin Ivanov – NRNU MEPhI*

Andrei Ivanov – NRNU MEPhI*

Igor Rudnev – NRNU MEPhI*

Vladimir Menushenkov – NUST MISiS*

Igor Shchetinin – NUST MISiS*

Alexandre Rafalsky – NUST MISiS*

Dmitry Zhukov – NUST MISiS

Report:

Introduction

The advances in rare-earth permanent magnets increase the interest in a complete characterization of various metastable phases that may play a critical role in determining the magnetic properties of the hard magnetic materials. The Nd-Fe alloys both the rapidly quenched (amorphous and partially amorphous) as well as in the crystallized state have been studied by many methods because of high coercivity and relation to Nd-Fe-B magnets [1, 2]. The interest in the Nd-Fe alloys maintained owing to the important role that the binary intergranular Nd-rich phase plays in the coercivity of Nd-Fe-B magnets.

Results and Discussion

XMCD spectra and magnetization loops of rapidly quenched and as-cast Nd-Fe alloys have been collected at the L_3 (E=6208eV) and L_2 (E=6722eV) absorption edges of Nd and at the K (E=7112eV) edge of Fe. We have investigated 3 samples of Nd-Fe alloys with different chemical or/and phase compositions (rapidly quenched and as-cast $Nd_{86}Fe_{14}$, rapidly quenched $Nd_{50}Fe_{50}$) with known coercive force. All measurements were made at ambient pressure at temperatures from 5 to 300 K and under magnetic field of 17 T.

Main results are summarized in Fig. 1 and 2.

XMCD spectra at Nd $L_{3,2}$ edges show monotonic decrease of the signal intensity for the temperatures from 5 to 300 K. This could be associated with spin-reorientation transition in Nd sublattice. Differently, for XMCD spectra at Fe K edge no change is observed in the temperature range 5-50 K, thus revealing different behavior of the Fe sublattice at lower temperatures.

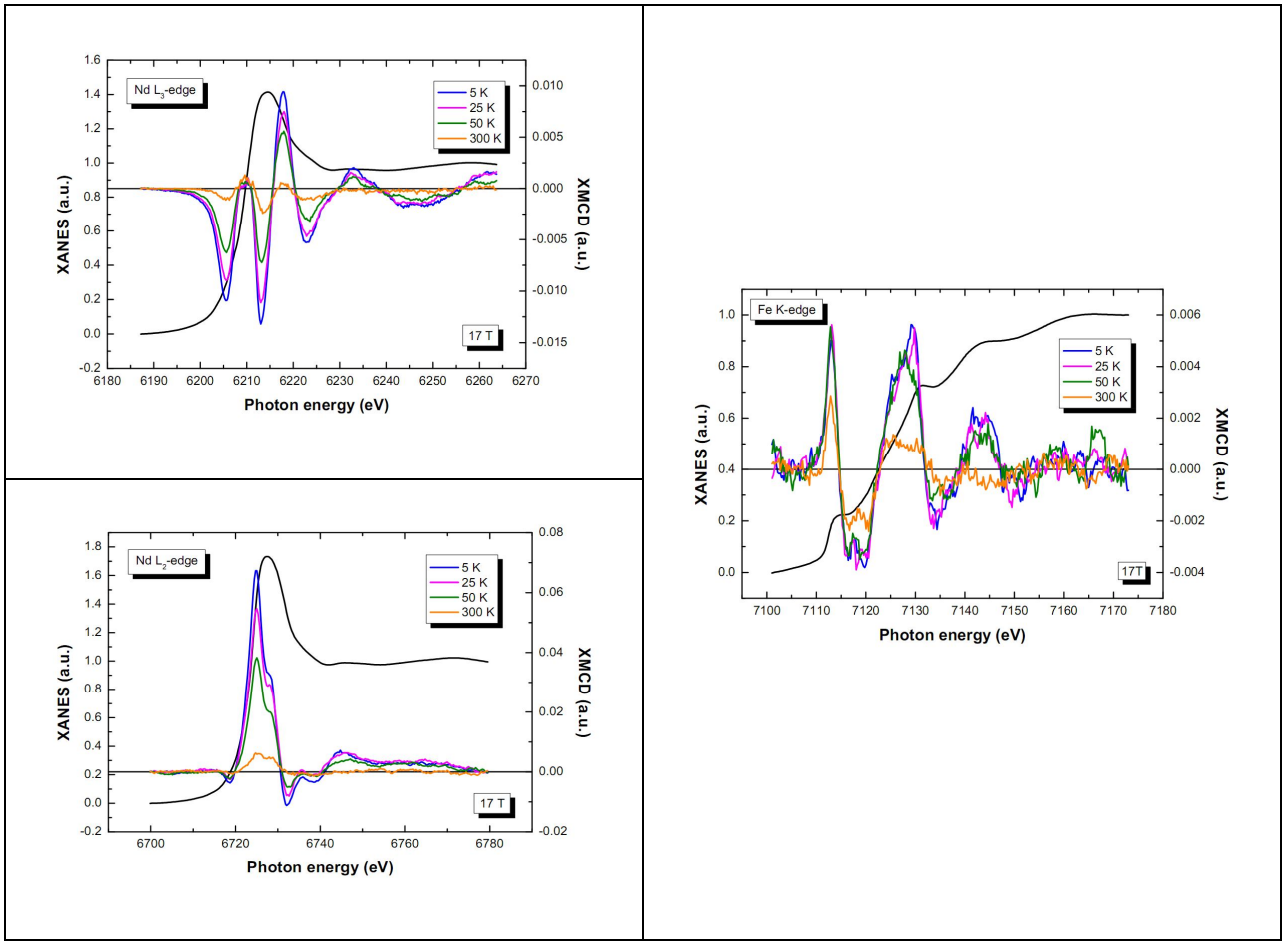

Fig. 1. XMCD spectra at Nd $L_{3,2}$ and Fe K edges acquired in 5-300 K for rapidly quenched alloy $Nd_{86}Fe_{14}$.

XMCD magnetization loops at Fe *K* edge demonstrate rather high coercive field about 5 T at 5 K with tendency to monotonically decrease down to 0.5 T at 300 K. At Nd L_2 edge the coercivity of 4 T is independent of temperature while magnetization decreases being not saturated for the Nd sublattice.

Reported element-selective loops will be compared to conventionally measured ones by means of vibrating sample magnetometer probing the whole sample.

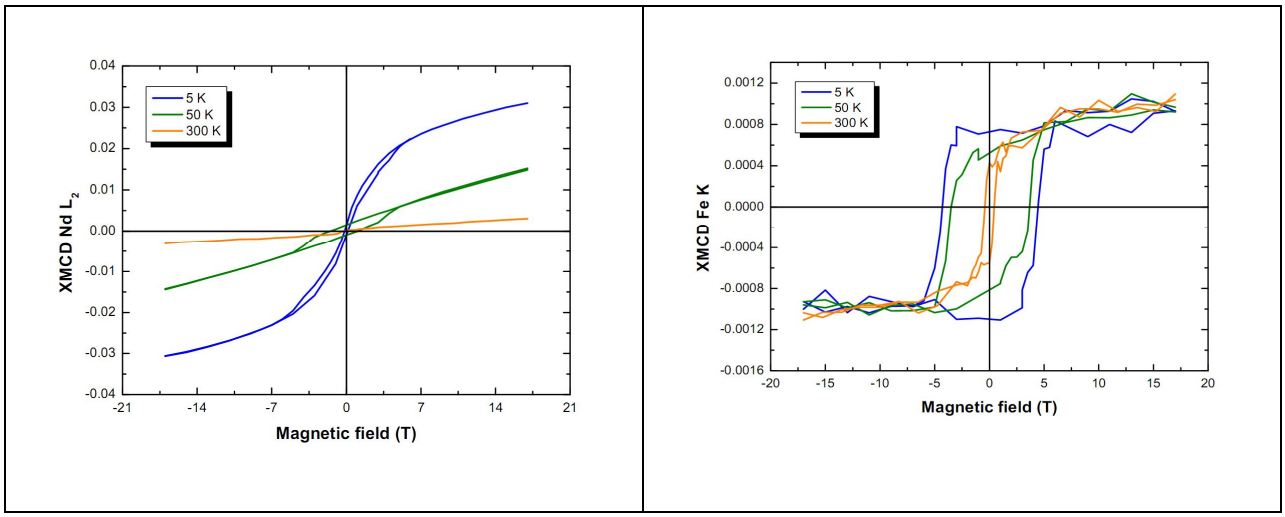

Fig. 2. XMCD magnetizationloops at Nd L_2 and Fe *K* edges acquired in 5-300 K for as-cast alloy $Nd_{86}Fe_{14}$.

Conclusion

By analyzing the obtained results we plan to get a deeper insight into the role that play Nd and Fe in the establishing of magnetic state in the intermetallic alloys Nd-Fe. We aim at separating the contributions of rare-earth and transition metal elements into overall magnetic properties of these compounds. We plan to determine the value and the direction of rare-earth and Fe magnetic moments as a function of composition and crystalline structure. These data would provide a key information to explain the influence of nanostructural nature of the samples on the peculiarities of magnetic state and high coercivity in Nd-Fe hard magnetic compounds. These data should allow us to optimize the processing technology for obtaining high-coercive state important for applications.

References

[1] V.P. Menushenkov, A.S. Lileev, M.A. Oreshkin,and S.A.Zhuravlev,J. Magn. Magn. Mater.1999, 203, 149.
[2] V.P. Menushenkov, I. V. Shchetinin, M.V. Gorshenkov, A.G. Savchenko, S. V. Ketov. IEEE Magnetics Letters, 7, 2016, 5201304–5201304.