EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Fabrication and Characterization of Magnetic Nanoparticle Monolayers in a Polymer Matrix	**Experiment number**:
Beamline:	**Date of experiment**: from: 12.09.2012 to: 15.09.2012	**Date of report**:
Shifts:	**Local contact(s)**: Oleg Konovalov	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Dr. VOROBIEV* Alexei, Petersburg Nuclear Physics Institute

Dr. GRIGORIEV Sergey, Petersburg Nuclear Physics Institute

Dr. DYADKINA Ekaterina, Petersburg Nuclear Physics Institute

Report:

Due to the technological progress of modern society in recent years there is increasing interest in new materials with advanced physical properties, which should lead to further evolution of nanoelectronics, spintronics, photonics, etc. Systems with self-organization and self-assembly are important part of this development. In this context, the monolayers of single-domain magnetic nanoparticles attracting considerable interest both from the point of view of possible applications, and for the fundamental theory of interaction and self-organization of nanoscale objects. In this research we investigated mono and bidisperse ensembles of magnetic nanoparticles on the surface of water in the self-organization process. We performed a unique combination of experimental methods: X-Ray reflectometry (XRR) and Grazing-Incident Small-Angle X-Ray Scattering (GISAXS), which allowed to study spacial distribution of electron density in the monolayer of nanoparticles both in depth and in the plane of the surface. A solution containing magnetic nanoparticles were deposited on the surface of the water in the Langmuir through, which were followed by isothermal compression, during which there was grow of homogeneous monolayer. The experiment was carried out on the ID10 beamline of the European Synchrotron Radiation Facility (ESRF, Grenoble, France). GISAXS scattering pattern of the 10 nm Fe_3O_4 nanoparticles ensemble were taken at an angle of incidence of synchrotron radiation $\alpha_i = 0.2^o$ and pressure in the layer P = 5 mN / m and it shown in Fig. 1a, Fig. 1c shows the intensity profile along the dashed line. Fig. 1b shows the corresponding scattering pattern for the bidisperse ensemble of 10 nm and 20 nm nanoparticles in the proportion 3:1.

The peaks at GISAXS scaterring patterns are corresponding to the the two-dimensional hexagonal lattice. The peaks (1 0) from the two-dimensional hexagonal lattices from of the monodisperse 10 nm (Fig. 1a) and bidisperse (Fig. 1c) nanoparticles ensembles are most pronounced. At scattering map from monodisperse sample (Fig. 1a) peaks (1 1), (2 0) and (2 1) is also visible. The main difference between the patterns from these systems is following: at the scattering from the bidisperse sample there are peaks (1 0), (1 1) and (2 0) from the 10 nm nanoparticles lattice and (1 0) from the 20 nm nanoparticles lattice, while in monodisperse sample there are peaks from only one subsystem.

The lattices constants of hexagonal lattice obtained from the GISAXS data is a_1= 11.5 nm in case of monodisperse sample and a_1= 13.2 nm and a_2= 23.0nm, where a_1 is the lattice constant of 10 nm nanoparticles subsystem and a_2 is the lattice constant of 20 nm nanoparticles subsystem.

Results of the GISAXS and XRR confirm stable and reproducible formation of a monolayer of particles of hexagonal packing layer at a pressure of about 5-10 mN /m.

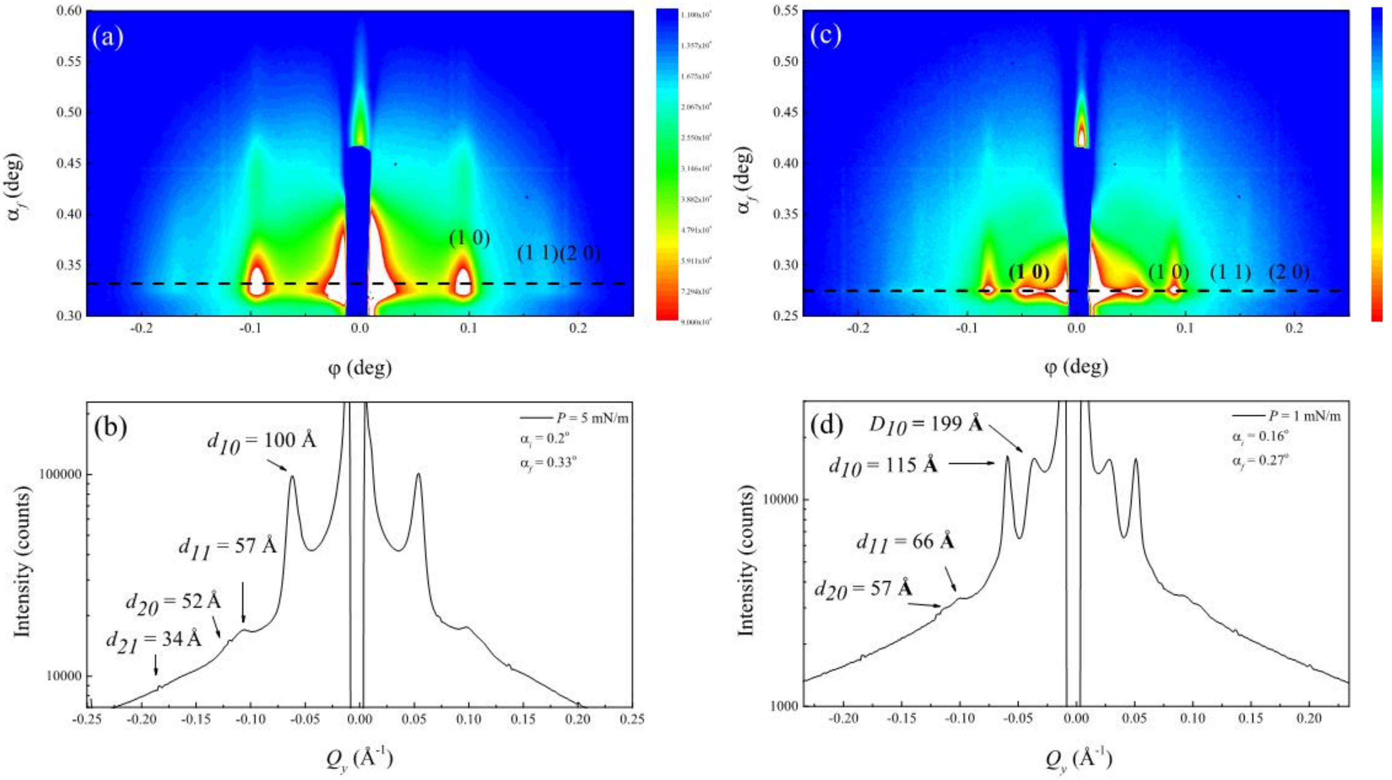

Fig. 1 GISAXS scattering patterns from (a) monodisperse 10 nm ensemble and (c) bidisperse 10 nm (3) 20 nm (1) ensemble at maximal applied pressure in the layer. Peak are indicated as a regular font text indexes for 10 nm nanoparticles system and as a capital font text for 20 nm system, respectively. Cuts along the GISAXS scattering patterns (higlighted as a dashed line) from (b) monodisperse 10 nm ensemble at fixed scattering angle $\alpha_f = 0.33^{\circ}$ and (d) bidisperse 10 nm (3) 20 nm (1) ensemble at fixed angle $\alpha_f = 0.27^{\circ}$.