EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

ESRF	**Experiment title:** Structure of isolated silver nanoparticles	**Experiment number**: **HC-3233**
Beamline: BM11	**Date of experiment**: from: 29.11.2017 to: 03.12.2017	**Date of report**: 06.02.2018
Shifts: 9	**Local contact(s)**: Dr. Marta Majkut	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Vakhrushev Sergey, Russian Academy of Sciences Ioffe Physico-Technical Institute

Naberezhnov Aleksandr, Russian Academy of Sciences Ioffe Physico-Technical Institute

Redkov Aleksei, St. Petersburg State Polytechnical University

Alekseeva Olga, St. Petersburg State Polytechnical University

Vanina Polina, St. Petersburg State Polytechnical University

Report:

The results of X-ray diffraction study of the structure of the isolated silver nanoparticles formed onto the soda-lime glass surface are reported. The samples were prepared by the method of out-diffusion [1], one of the authors of which is present in the experiment team. The method consists of two stages. The first one is thermal poling of silver ion-exchanged glass using nanoprofiled electrode made by e-beam lithography. This ensures silver ions penetration deeper into the glass in places where the electrode was in contact with glass surface. The second stage is annealing of the samples in hydrogen atmosphere. During this stage silver ions in near-surface layer are being reduced to neutral state and then self-organize into isolated silver nanoparticles on the surface of the glass, repeating the structure of used electrode. SEM image of the square array of isolated silver nanoparticles, used in the ESRF experiment is presented in Fig 1. The array contains hemispherical particles of 80-200

nm in diameter mesured by SEM. The distance between nanoparticles is 5 μm. The thickness of the glass substrate is 1mm.

We succeeded in demonstrating that the diffractometer provides a sufficient luminosity for observing diffraction on nanosamples. Scattering from both the polycrystalline islands (Fig. 2, rings) and the set of single crystals (Fig. 2, sattellites) is clearly seen when the incident beam is directed along the surface of the sample. Diffraction patterns odtained under the conditions of "perpendicular" geometry are characteristic for individual nanocrystals (Fig. 3). It confirms the sufficient spatial resolution of the device. The more detailed study of the structure requires a transition to more thin samples that do not contain polycrystalline islands.

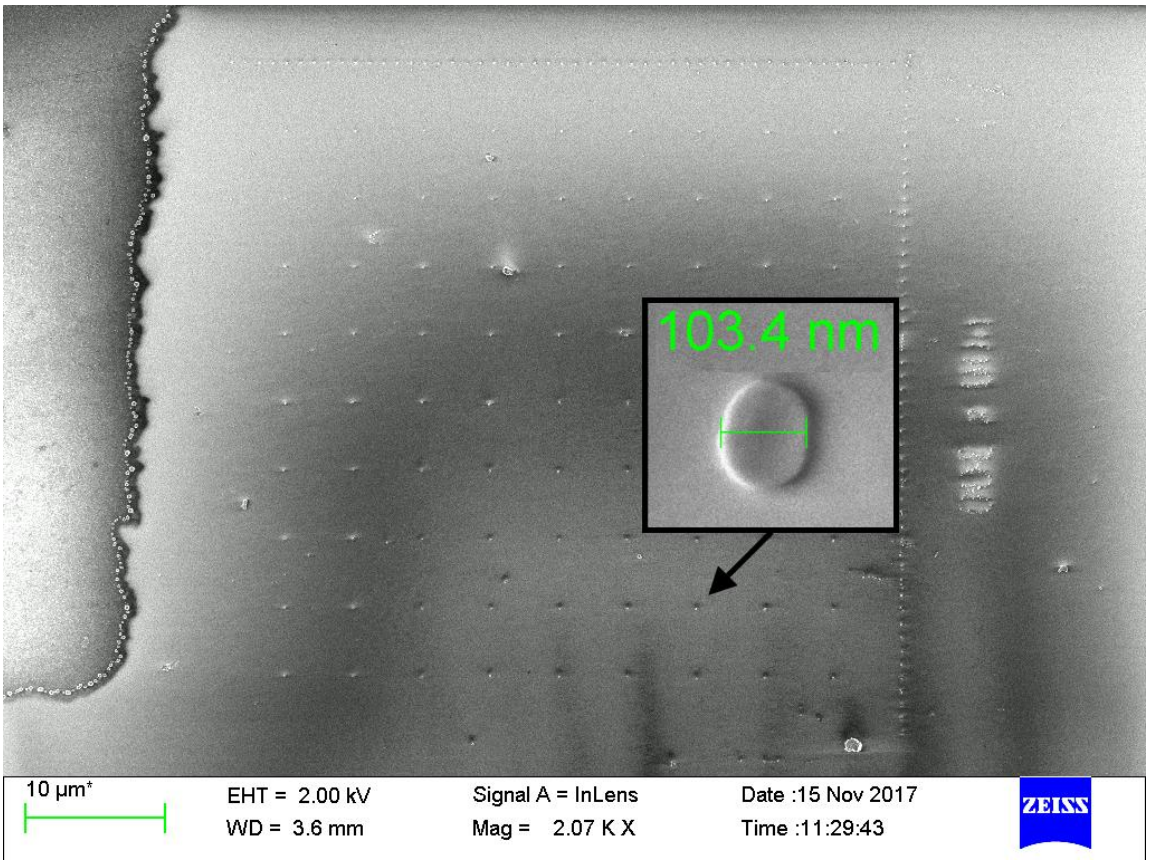

Figure 1. SEM image of the array of single nanoparticles used in experiment.

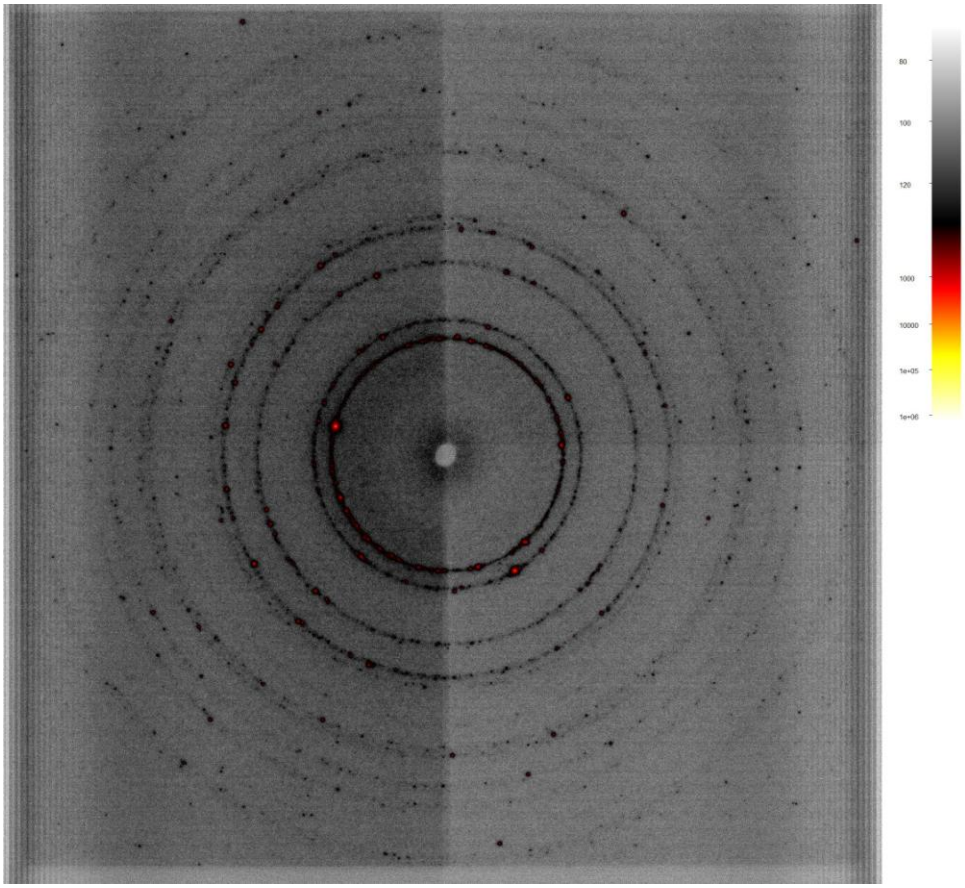

Figure 2. Diffraction patterns (the incident beam is directed along the surface of the sample).

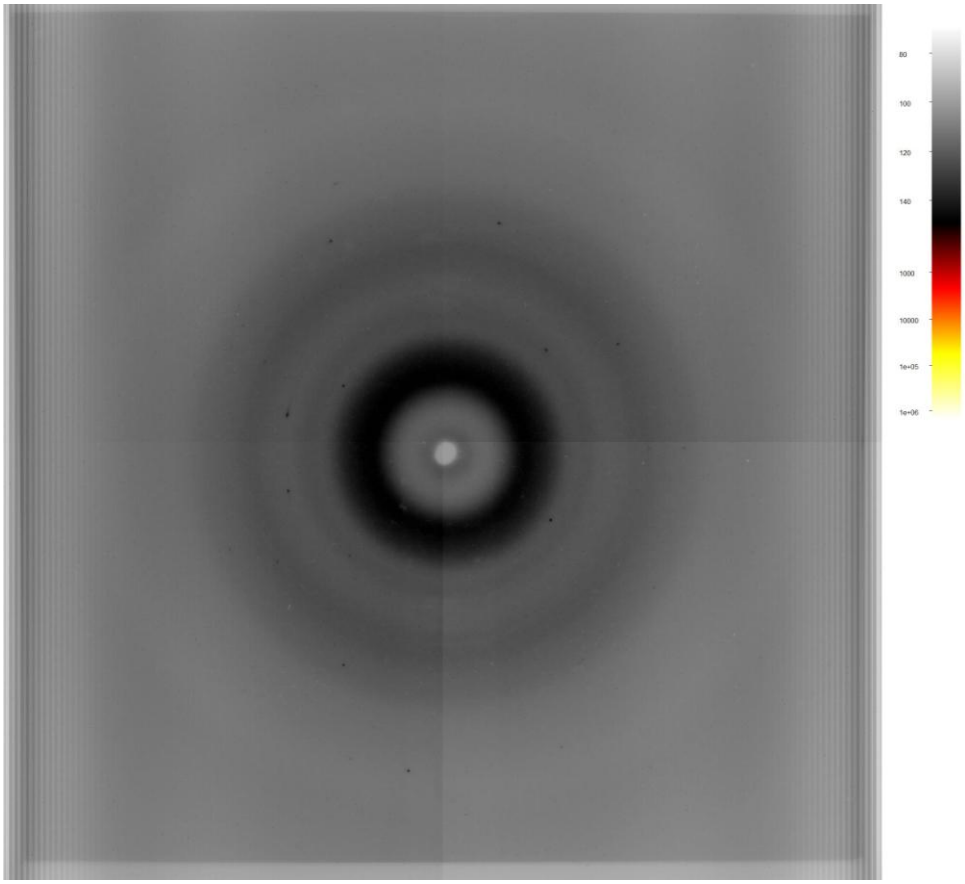

Figure 3. Diffraction patterns (the incident beam is directed perpendicular to the surface of the sample)

[1] Chervinskii S.D., Redkov A.V., Reduto I.V., Sergeev V.Yu, Lipovskii A.A., RF Patent № 2562619 “A method of forming of structured solid and nanoisland films on the surface of the glass.” 20.02.2014