ROBL-CRG	**Experiment title:** **X-ray absorption spectroscopy studies on gold nanoparticles fromed by bacteria and their surface layer proteins**	**Experiment number**: **20-01-638**
Beamline: BM 20	**Date of experiment**: 05.03.-06.03.05; 29.09.-03.10.06	**Date of report**: 12.01.07
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Report: The fabrication of patterned arrays of nanoparticles whose electronic, optical and magnetic properties will find technological applications, such as ultra-high-density memories, is currently one of the most important objectives of inorganic material research. In this study, the size of the Pt nanoparticles formed on the S-layer proteins of *B. sphaericus* JG-A12 was estimated using a combination of X-ray absorption spectroscopy (XAS) and Iterative Target Test Factor Analysis [1].

Experimental: *B. sphaericus* JG-A12 was routinely grown in NB medium. The preparation of S-layer protein was performed as described in [2]. For sorption of Pt(II), 10 mg of dialyzed protein was incubated in 100 ml of a solution of 2 mM K_2PtCl_4 overnight at room temperature in the darkness. Pt(II) was reduced by the addition of a few drops of 100 mM DMAB to produce Pt(0)-nanoparticles. The metallized protein samples were centrifuged (20 min, 10000 × g) and dried in a vacuum oven (48 h, 30°C).

Results: Figure 1 shows the XANES regions of the EXAFS spectra obtained with Pt-treated S-layer after addition of DMAB and for reference compounds containing three oxidation states of platinum: Pt(II) (solution of 2 mM K_2PtCl_4), Pt(IV) and metallic Pt (platinum foil). Comparison of the experimental spectra to the reference spectra clearly shows that Pt is present as metallic Pt and Pt(II) in the Pt-treated S-layer. To determine the relative amounts of Pt(0) and Pt(II) present in the biological sample, we applied Iterative Transformation Factor Analysis. The calculation revealed a mixture of 52% metallic Pt and 48% Pt(II) for the S-layer sample. Pt L_{III}-edge EXAFS spectrum of the Pt/S-layers of *B. sphaericus* JG-A12 in presence of

DMAB is shown together with Pt foil in Fig. 2. In this sample, Pt is present mainly as metallic phase where the interatomic distances found are comparable with the one of metallic foil. The coordination number (N) is different from the bulk ones, showing the presence of small metal particles. The reduction of the coordination number of the first shell is used to estimate the average particle [3]. The coordination number value of the Pt-Pt found in this work (5.5 ± 0.4) is not the real coordination number of the Pt per nanoparticle. This value corresponds to the coordination number of Pt-Pt per sample. The coordination number of latter bond per nanoparticle is weighted by the atomic percentage of Pt atoms in the metallic phase [3]. It was found that the nanoparticles deposited on the S-layer protein have a mean diameter of about 2.5-3.5 nm. These results are in agreement with those found using synchrotron-based X-ray diffraction studies (v. Borany, personal communication).

Fig. 1.

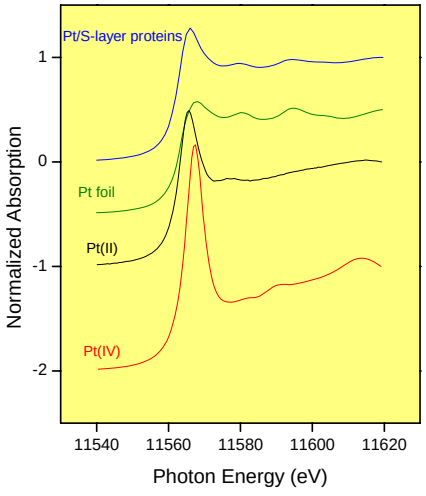

Fig. 2.

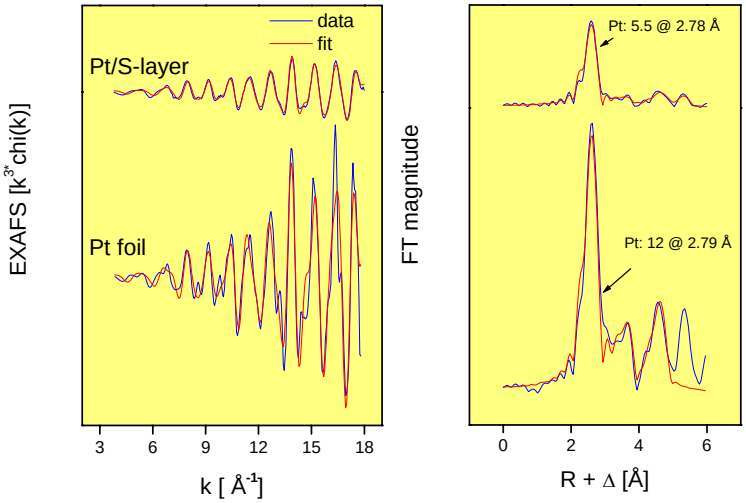

Fig.1: XANES region of EXAFS spectra of the Pt L_{III}-edge in reference compounds and for Pt-loaded S-layer of *B. sphaericus* JG-A12.

Fig.2: Pt L_{III}-edge EXAFS spectra and their corresponding fourier transforms of Pt-treated S-layer of *B. sphaericus* JG-A12 and Pt foil.

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