ESRF	**Experiment title:** Combined Laser Tweezer/Diffraction Experiment for the study of Radiation Damage on Single Starch Particles and Lipids	**Experiment number**: SC-2460
Beamline: ID13	**Date of experiment**: from: 02/07/2008 8:00 to: 07/07/2008 8:00	**Date of report**: 01.09.2009
Shifts: 15	**Local contact(s)**: Christian RIEKEL	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

D. Cojoc (a)*, H. Amenitsch (b)*, C. Riekel (c)*

E. Ferrari (a)*, M. Rappolt (b)*, M. Burghammer (c)*

S. Santucci (a)*, G. Grenci (a), B. Sartori (b), B. Marmiroli (b)*

(a) TASC National Laboratory, Trieste, Italy

(b) Institute of Biophysics and Nanosystems Research, Austrian Academy of Sciences, Graz, Austria

(c) ESRF,

Report:

In the beamtime of the report we conducted various experiments: (i) Test of the Radiation damage on single starch molecules held by optical tweezers. (ii) Test of the applicability of optical tweezers to manipulate single $CaCO_3$ crytsals.

(i) Radiation Damage on single starch molecules

The intention of the present proposal was the study of the **radiation damage** and the protection of **free-radical scavengers** on single trapped particles. Therefore we trapped and fixed single starch granules with single and multiple traps by means of a costum build optical tweezer set-up [1,2]. Additionaly we have exchanged the solvent containing various **free-radical scavengers** at various concentrations, i.e. succrose 3%, glyceol 1.5% and ascorbic acid 10% [3]. By combining loop and mesh scans the radiation damage of the hard X-ray radiation (λ=0.98 Å) could be studied on single startch granules. The global analysis of the scattering data allowed us the discriminate the effect of structural damage and the transformation of the material by the photoelectrical effect. Moreover we were able to obtain microscope images during and after the radiation damage. By combining all this information we were able to obtain the following results: (i) The radiation damge is determined mainly by the direct photoelectric effect and causes an immediate damage (after 200 ms). (ii) Besides the change of the supramolecular as well the side chain order also a dissociation of the molecules appears manifested in the change of the Porod slope form plate like (porod constant = 2) to molecular chains (porod constant = 1), see Fig. 1, i.e. on the nanoscopic level the molecules loose their plate like packing and form isolated enlongated molecules with a high porosity (= high surface to volume ratio). The differences of these two effects can be

used to image the order and the disorder inside the particles after drilling a hole in the particles with the X-ray beam by making a scanning diffraction experiment [3,4].

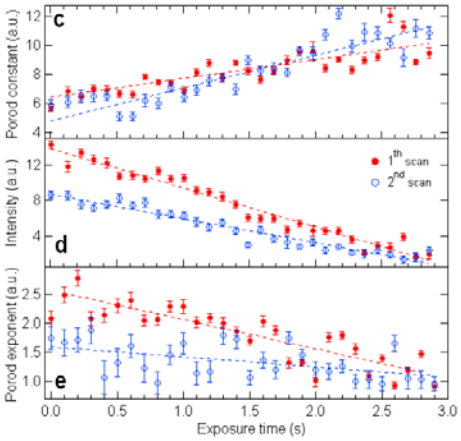

Fig. 1 Pannels demonstrate the main structural parameters during the time course of the first (red) and second (blue) radiation damage cycle of the particle shown in Fig. 2. While the Porod constant (c) monotonously increases, which is proportional to the inner surface of the exposed sample volume, the intensity of the WAXD peak at q = 4 nm^{-1} (d) and the Porod exponent (e) monotonously decrease changing from values about 2 (plate like) to values around 1 (cylindrical) at a structural level of several Angstroms.

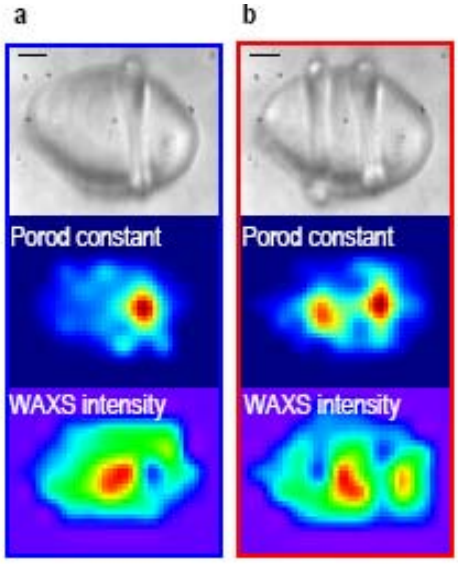

Fig. 2 Controlled radiation damaging of trapped starch particles. (**a**) displays on the top a microscope image of a starch particle that has been fixed with a triple focus OT trap (top view, scale bar 10 µm). The X-ray micro-beam that impinged the particle was so intense that it drilled a hole into the right hand side of the particle (1st scan, red). (**b**) After shifting the sample cell 12 µm to the right side, a second hole was drilled into the left side of the particle (2nd scan, blue). Further, the starch particle was mesh-scanned with a step size of 4 µm, and the determined Porod constants at each mesh point were used to reconstruct the image of the starch particle (X-ray view). At the bottom of panel (**a**) and (**b**) clearly the two holes appear as porosity maxima in the reconstructed images. In the two images below (WAXS images) the WAXS peak intensity was shown to reconstruct the image.

(ii) Optical Manipulation of single Calcite Crystal

In order to test the applicability of OT's to manipulate protein crystals we have measured a mesh scans of various calicite crystals and tried to manipulate their orientation in the trap. The first results of the mesh scans is shown in Fig 3, in which the orientational stablity has been tested.

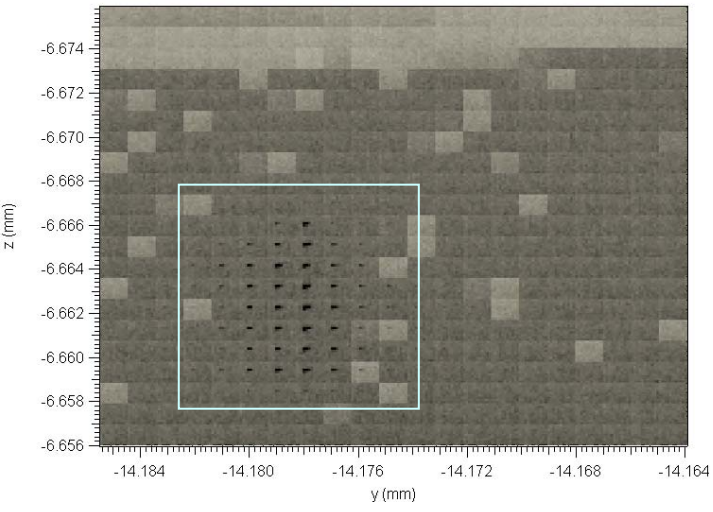

Fig. 3 Mesh scan of a traped single calcite crystal, in which only the regime of the single (106) reflection is shown. The blue box indicates the trapping volume and demonstrates that the orientation remains stable in the trap during the scans. Repeated scans have shown the stability.

References

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