EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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:** High resolution SAXS and WAXS investigation of cuticular hair-like mechano-sensor	**Experiment number:** LS-2461
Beamline: ID13	**Date of experiment:** from: 1/11/2015 to: 5/11/2015	**Date of report:**
Shifts: 9	**Local contact(s):** Martin Rosenthal	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Here we report on our high-resolution scanning SAXS/WAX experiments at ID-13 aimed at determining the micro-structure of the spider mechano-sensors, specifically the organization and orientatin of the chitin fibers within the samples.
The two common classes of external mechano-sensory systems in spiders are the strain-sensitive slit-sensilla and the hair-like sensilla which are subdivided into airflow sensitive trichobothria and tactile hairs. As part of the spider's cuticular exoskeleton, the strain-sensitive organs and the hair-like receptors consist of chitin fibers embedded within a matrix of proteins. The properties of the cuticle are dependent on the fiber orientation as well as the properties of the matrix and its hydration level. The topic of this proposal is the structure-properties relationship in spiders mechanical sensors, specifically the air flow and touch-responsive hair-selsilla. We wish to perform scanning-diffraction experiments to determine the chitin-fiber content, orientation and alignment within individual hairs and how these change along the hair shaft.We collected data from 3 mechano-sensor types: (1) Tricobothria airflow sensors (2) tactile-hair touch receptor and (3) Slits strain sensors.

Experimental Procedure

Sample preparation:

The hair-like sensors (trichobothria and tactile hairs) were mechanically removed from the spider (Cupiennuius salei) and placed on a silicon-nitrid window frame. The samples were fixed to the membrane with a small drop of glue.
The slits organ were prepared as sestions where the entire matatarus of the spider were disected using a vibratome while immersed in water. these sections were then either glued to similar silicon-nitrid windows as the hairs with a drop of glue or sandwiched between two frames in order to perserve their humidity level.

Data acquisition:

Measurements were performed at ID-13 at the nano-focus station (hutch 3). Thanks to the small spot size avilable at this station (200 nm) we could obtain data with high spatial resolution. The beam energy was set to 15 KeV. In addition the newly acquiered large area Eiger detector with high dinamic range used allowed us to obtain high qulity SAXS and WAX data simultanesly. Acquisition time varied between 1-1.2 sec/point depending on the sample thickness and step size was 400 nm to minimize radition damage.
All together we have measured 20 from 3 slits organs, 3 trichobothria and 3 tactile hairs. In addition we have performed preliminary experiments to test the possibility of micro-mapping calcitic sea urchin spine.

Data evaluation:

The data obtained in these measurements is being analyzing using fit2D and DPDAK to extract (1) and estimate of the chitin content (using orthogonal chitin reflections) (2) chitin fiber orientaion (using the packing peaks of chitin at q~1.3) (3) the degree of fiber orientatino (using rho parameter analysis). The SAXS data is being analyzed for variations is slope (form factor analysis) and structure factor. In addition we are mapping the position of the (020) peak which tells about the interaction of proetins with the chitin crystllites [1].

Results:
We have obtained strucutral data with high spatial resolution for all measured samples. The results still being analyzed and point toward major role of chitin fiber orientation with relation to the samples mechanical properties. The results on the slits are being finalized to be incorporated in a publication discussing the structure-propetes of the slits in relation to their mechano-sensing function. The data on hair-like sensors is a starting point for a thorough structural, chemical and mechanical charachterization of the hairs and the cuticle in which they are embedded.
An example for the analysis and information we extract from the measurements are seen in figure 1 produced from data obtained during our previous measurements (SC-3434).

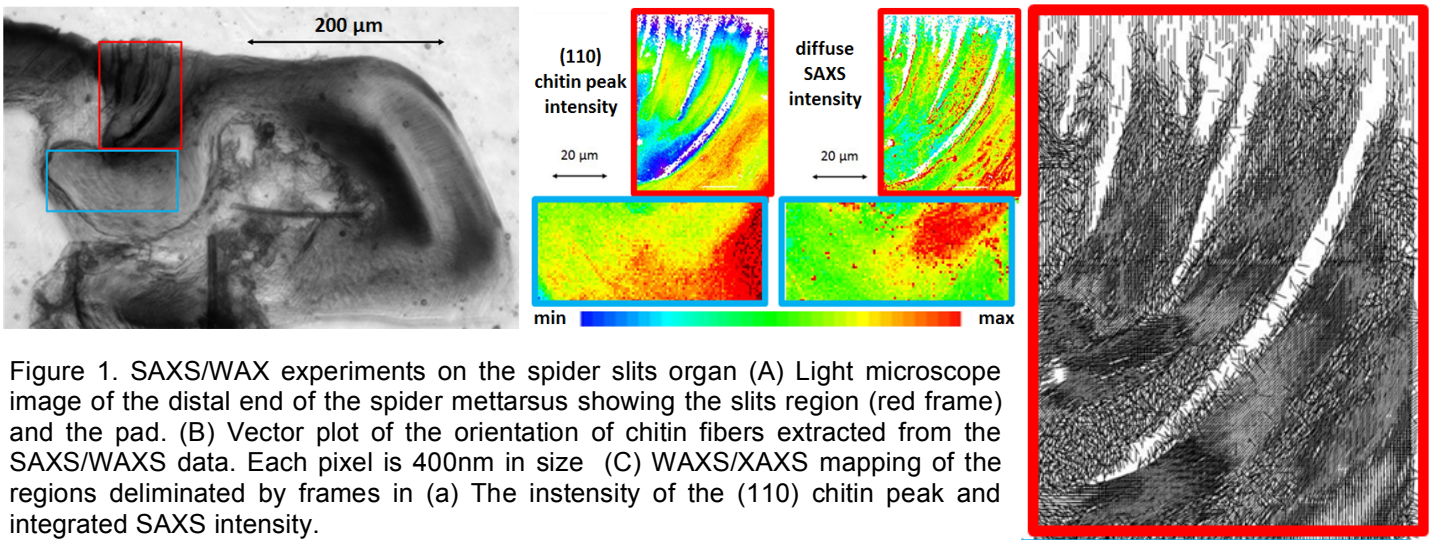

Figure 1. SAXS/WAX experiments on the spider slits organ (A) Light microscope image of the distal end of the spider mettarsus showing the slits region (red frame) and the pad. (B) Vector plot of the orientation of chitin fibers extracted from the SAXS/WAXS data. Each pixel is 400nm in size (C) WAXS/XAXS mapping of the regions deliminated by frames in (a) The instensity of the (110) chitin peak and integrated SAXS intensity.