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 using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now 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.

<table>
<tr><td>ESRF</td><td>Experiment title: Mechanism of conductivity variation in organic memristor by X-ray reflectometry measurements</td><td>Experiment number: SC-3043</td></tr>
<tr><td>Beamline:
ID10B</td><td>Date of experiment:
from: 09/11/2010 to: 16/11/2010</td><td rowspan="2">Date of report:
12/10/11

Received at ESRF:</td></tr>
<tr><td>Shifts: 18</td><td>Local contact(s): Dr. Oleg Konovalov</td></tr>
<tr><td colspan="3">Names and affiliations of applicants (* indicates experimentalists):
1. Victor Erokhin*, CNR and Department of Physics, University of Parma, Italy.
2. Svetlana Erokhina*, Department of Physics, University of Parma, Italy.
3. Yuri Gunaza*, Department of Physics, University of Parma, Italy.
4. Konstantin Gorshkov*, Department of Physics, University of Parma, Italy.
5. Tatiana Berzina*, CNR and Department of Physics, University of Parma, Italy.
6. Paolo Camorani*, Department of Physics, University of Parma, Italy.</td></tr>
</table>

Report:

Real-time ion distribution mapping in organic memristor by X-ray fluorescence

Functioning of the organic memristor is based on the conductivity variation due to the redox reactions in polyaniline. These reactions involve ion motion between the active layer and solid electrolyte.

The aim of the experiment was to make real-time mapping of the distribution of ions along the working area of the memristor during its functioning. Special attention was paied to the study of the periodic variation of the ionic profile in the mode of current oscillation generation.

Scheme of the experiment is shown in Fig. 1

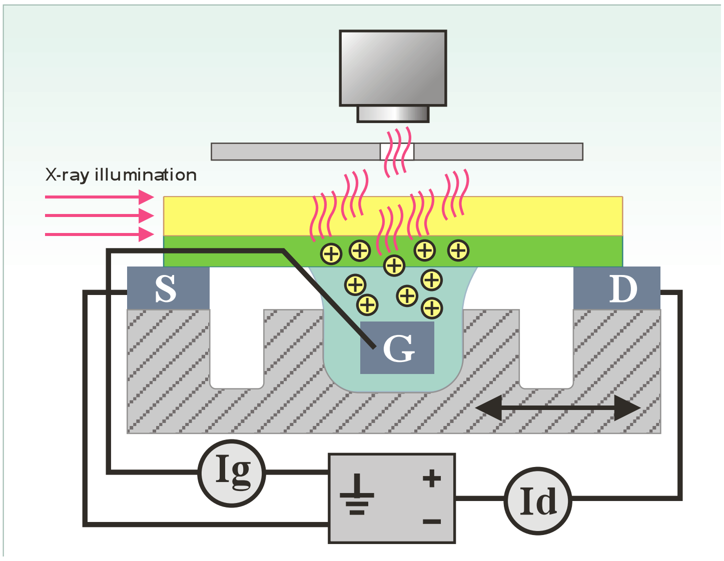

Fig. 1. Scheme of the experiment.

Active layer of polyaniline (green layer) was deposited onto thin Kapton film (yellow layer). The film was placed on the sample-holder, providing metal contact to the polyaniline layer. Electrolyte, based on the gel of polyethylene oxide with Rb salt, was added to the well in the central part of the sample-holder. Polyanilyne was placed in the contact with the electrolyte. Reference electrode was placed into the electrolyte gel. X-ray fluorescence was excited by the grazing-angle incident X-ray. Fluorescence was analyzed by the detector, placing an aperture between it and the sample. Displacement of the sample during measurements allowed to determine the distribution of the Rb ions along the active zone (contact of polyaniline with electrolyte).

The experiment was started with the calibration of the detector. Two lines, corresponding to the Rb fluorescence were identified and their integral intensity was used in the following experiments.

Variation of the Rb fluorescence in the active layer in time during the measurements of the cyclic voltage current charactiristics is shown in Fig. 2.

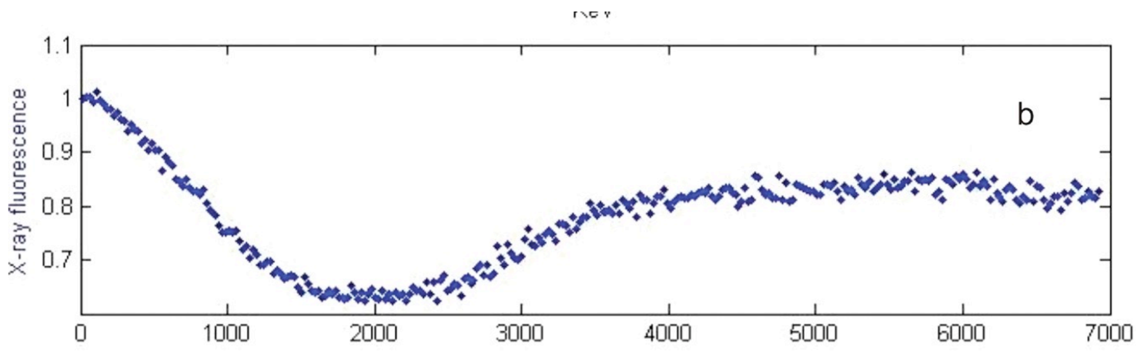

Fig. 2. Temporal variation of the Rb fluorescence in the active layer in time during the measurements of the cyclic voltage current charactiristics

The measurements were started at 0 V and increased til +1.2 V. Then, the voltage was decreased till – 1.2 V and increased again till 0 V. First measurenents were done without operture collecting the fluorescence intensity from the whole sample.

It was found a direct correlation of the conductivity with the integral intensity of Rb in the active zone.

Experiments on the profile determination were first carried out by studying the kinetics at fixed bias voltages: +0.8 V and -0.3 V. The first value (scans 64-78) corresponds to the oxidation of the polyaniline and transformation of the memristor into the conducting state. The second value (scans 79-91) corresponds to the reduction potential of polyaniline and transformation of the memristor to the insulating state.

Thickness of the polyaniline in the active layer was varied from 24 to 96 nm.

Each measurement requiered the determination of the working point (in depth). Thus each sample was scanned in z direction and the position was determined analyzing the intensity of the transmitted exciting X-ray radiation.

Mapping of the fluorescence intensity was done in the reduced voltage range (-0.6 - +0.8 V and -0.6 - +1.0 V) with increased time delay in order to have more time for the sample displacement at each voltage value.

Autooscillation measurements were performed by attaching an external capacitor of 4.7 mF in the circuit of the reference electrode. Oscillations were observed not for all measurements (it is a normal behavior in previous measurements of the electrical characteristics). Different samples with different bias voltages were measured. The best oscillations were observed at +7.0 V bias voltage (scans 595-667 and 688-1166).

Analysis of the data have revealed a serious difficulty in the connection of the X-ray fluorescence data with those of the electrical characterization, due to the fact that these measurements were controlled by different computers, what have resulted in the difficulties in the sinchronization of these independent measurements. However, the material we have obtained during the experiment has demonstrated the possibility of the real-time mapping of ion distribution and the only requirement is a better sinchronization of the electrical and X-ray measurements.