STSM Visit Report for Peter Cicman

Electron Induced Processing at the Molecular Level (EIPAM)

Exchange Grant

Reference Number : 413

Title: A new Instrument to study cold electron-solid interactions: testing and first experiments (1st December 2004 to 31st May 2005).

Scientific Report

The aim of the scientific mission was to participate in construction and testing of a new apparatus on the ASTRID storage ring at the University of Aarhus (http://www.isa.au.dk/astrid/astrid.html). This is a novel experiment, unique in its ability to form very low energy electron beams at high resolution in the near-zero to 100 meV energy range. The low energy electron beam impinges on a dielectric solid of known characteristics and composition, which will be lay down on a tantalum substrate in a separate preparation chamber. It is planned to measure the ability of electrons to pass through solid films of material, initially liquid N_2 cooled, as a function of electron impact energy.

A photograph of the experiment is shown in Figure 1. The light from the ASTRID synchrotron (University of Aarhus) is focused into the ionization chamber and detected by a photodiode. In the ionization region, electrons are produced by photoionization of Argon. They are then accelerated and focused by the electron optics downwards to the interaction region. There, depending on the type of experiments, the sample holder (for solid films experiments) or detection optics (for gas phase experiments), shown in Figure 2, can be moved into position. A trochoidal electron monochromator (TEM - see below) is mounted inside the mounting block, to provide an alternative source of electrons to the synchrotron photoionization source. A photo of TEM is shown in Figure 2, lower right.

From the start of the visit, I was involved in designing and commissioning the conventional TEM electron source, and incorporating it into the present design, so that we can test the new instrument without using synchrotron radiation (SR). This electron source has a form of Trochoidal Electron Monochromator (TEM), of which I have a extensive experience from my working group in Innsbruck. Such a design process involved preliminary calculation and design work followed by extensive simulation work, to assure that the design is suitable for present experiment. This design work was done simultaneously with a good

deal of other construction work in this rather complex instrument, needed for the experiment at the time, as necessary.

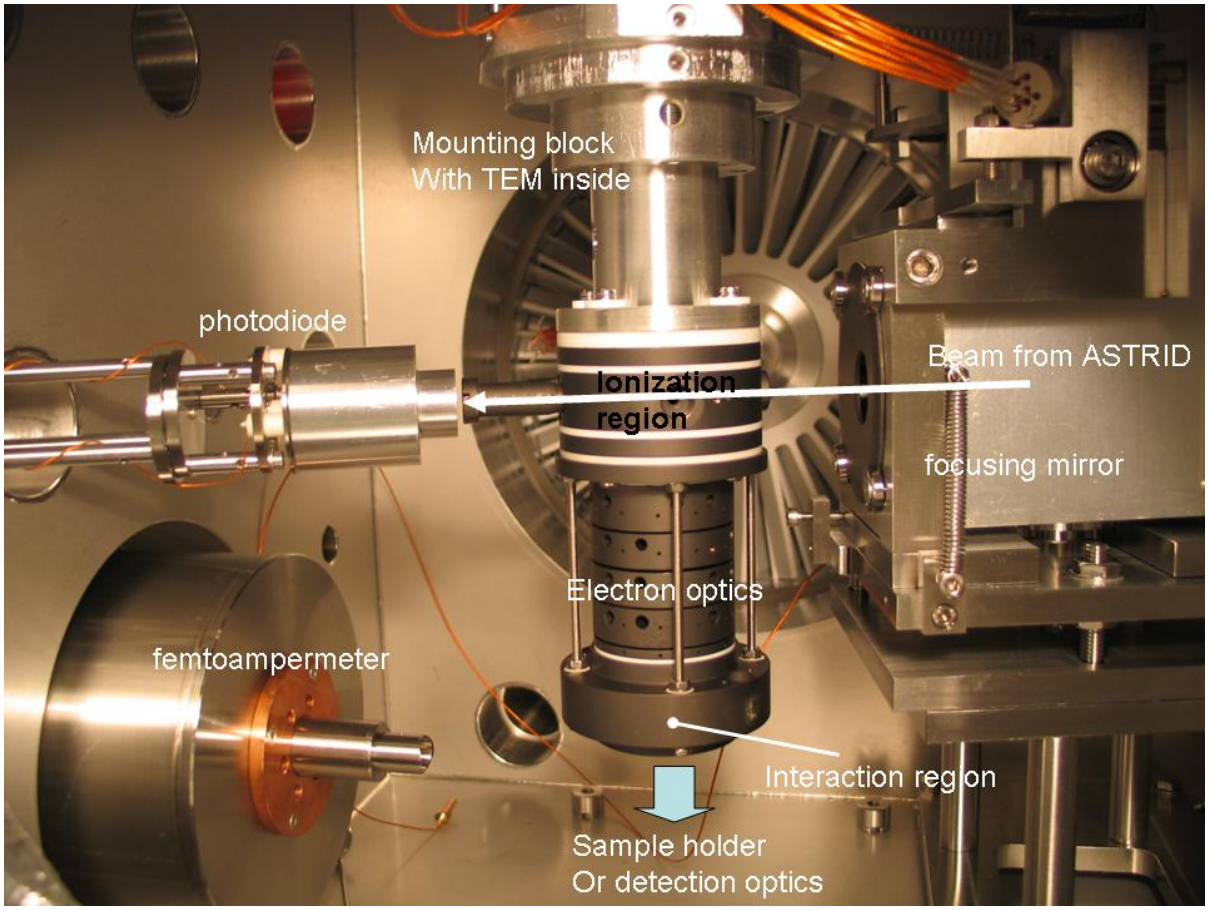

Figure 1 Photo of the experimental setup.

The experiment has been assembled into a form which made it possible to place it on beamline. Some weeks of synchrotron radiation from ASTRID was used for the precise optical alignment, crucially necessary for the correct working of the experiment. During this procedure, modifications to the experiment were found necessary in order to fit into the design and in many cases to improve the experiment.

After checking the experimental parts and components separately and their alignment, we designed and constructed the electrical connections and wiring needed for the machine. Apart from mechanical precision, this is another crucial component of the experiment. Great care and lot of time was taken to ensure, that the electrical and noise disturbances in

experiment were minimized. Finally, after completing the mechanical and electrical parts, the pumping and gas inlet system were constructed and put up in place.

Figure 2 Photos of the sample holder (on the left), detection optics (upper right) for experiments involving solid films or gas phase respectively. Lower right shows a photo of the newly designed electron source – Trochoidal Electron Monochromator

During all the procedures, described above, some original designs had to be modified. This was, however, not very unexpected as the design and building such a sensitive and

complicated experiment is a very difficult task. In many cases the redesign of the experiment has improved the experiment, not only physically but also mechanically. Although the modifications and redesign, together with delivery delays from some companies, brought delays in the schedule, the main part of the proposed work has been successfully executed. The experiment is presently, connected to beamline and all its parts are practically ready.

The details on the experiment and testing of the experiment will be presented soon at the EPIC/EIPAM Meeting in San Martino al Cimino, Viterbo 25-30 June, 2005. The first results of the experiment are planned to be presented at LEEMI IV conference in Smolenice, Slovakia, 6^{th} – 9^{th} October 2005.

The work, done during my exchange grant visit in Aarhus is beginning of the work in which I will be involved in the future. This work includes cooperation of the institutes in Innsbruck and in Aarhus. In Innsbruck, the gas phase experiments with biolmolecules (DNA bases, deoxyribose etc.) were already performed, while in Aarhus the experiment with molecules deposited on surfaces will enable to extending the knowledge about the interactions of electrons with these molecules laid down as films on surfaces. Similarly, the molecules of atmospheric interest (some of which are already measured in Aarhus, Innsbruck and elsewhere in the gas phase) will be deposited on the surfaces and investigated. Such experiment contains very interesting science and are important for biology (DNA damage), nanofabrication, atmospheric chemistry, and astrobiology.

I would like to thank to EIPAM program for the possibility to participate in this exciting work in the group of Prof. David Field at the Institute for Physics and Astronomy of University of Arhus. Whilst I have been at Aarhus, a successful application has been made to the Danish funding agency for a year’s post-doc in Denmark. I will therefore be continuing the work which I have begun here.