Mission Report: Short Term Scientific Mission (STSM)

Visit to Institut für Chemie, Physikalische und Theoretische Chemie, Freie Universität Berlin – Group of Prof. Eugen Illenberger by Tony Merrigan

Through the COST UK program an opportunity was presented to observe a project of Prof. Illenbergers looking at electron attachment to biological molecules produced in the gas phase by the method of laser induced acoustic desorption (LIAD).

This project is of interest due to similar work which our group is in the process of carrying out. The visit presented the opportunity to get to meet with the people involved in the project, to see the experimental arrangement and to have a number of questions with regard to the project answered.

The process of LIAD involves targeting the back of a metal foil with a pulsed laser, resulting in the production of an acoustic wave which travels through the foil. This wave weakens the bonds binding the sample of biomolecules to the front surface of the foil. The molecules are desorbed from the surface into the gas phase where they can then undergo various interaction processes. The experimental arrangement at the Freie Universität consists of a Nd:YAG laser operating in the second harmonic (532nm, maximum pulse energy = 12mJ) which is used for the production of the acoustic wave. A titanium foil (~ 13μm thick) was used for transmission of the wave. There is an associated ablation of the titanium foil by the incident laser. This ablated material can cause problems if it is sprayed onto the window through which the laser enters the vacuum system. Because of this, a small piece of glass is placed directly behind the foil to trap any ablated titanium.

The acoustically desorbed material is then irradiated by a continuous beam of low energy electrons. The effects of electron attachment to the desorbed molecules is analysed by extraction of the products into a Quadrupole mass spectrometer. The experimental arrangement currently in place by the group of Prof. Illenberger is a preliminary one put together to test the feasibility of such a system. The pulsed nature of this experiment however means a quadrupole mass spectrometer is probably not the ideal choice. And it was pointed out during the visit that the system would benefit from modifications to deal with this pulsed desorption technique, such as the addition of a time of flight mass spectrometer.

One of the biomolecules which has been experimented with using the LIAD technique was Uridine MonoPhosphate, a nucleotide that is found in RNA. It was observed that when this molecule was desorbed there was quite a large pressure change in the system, from 10^{-7} mbar base pressure to 10^{-5} mbar after desorption. This seems to indicate that a sufficiently large quantity of material can be brought into the gas phase by this method and could prove to be a very useful means of producing a gas phase target of biomolecules.

The LIAD technique, seems to have very little dependence on the wavelength of the laser used to induce acoustic desorption but rather is dependent on the fluence incident on the foil which can effect the amplitude of the acoustic wave and hence the amount of material which can be desorbed at any one time. It was also noted during the visit that sample thickness did not affect, observably, the sensitivity of the process; therefore thicker samples could be used to reduce the need for replacement of sample.

It is the objective of our group at Queen's University to look at the effects of ion irradiation of biomolecules in the gas phase. We have been developing a method of direct laser desorption from a surface to produce a gas phase target of biomolecules. One of the difficulties to overcome in such a method is the fragmentation and decomposition of the molecules being desorbed. The laser induced acoustic desorption method may prove very effective in minimising any thermal damage caused to the molecules under study. However, it is still not clear from the work done by the group of Prof. Illenberger, or from other groups using this technique, if the molecules that are being produced in the gas phase are isolated molecules or if they are being produced in clusters. From what has been observed by the visit to the Frei Universitat however, is that the method of desorption is something we ourselves can try and duplicate.

Overall the visit to see the LIAD experiment has proved to be very successful. It has provided useful information from those who have acquired experience in the areas of biomolecular target production and radiation interaction with these targets.