Impression of working at the RICE University in Houston

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I remember the warm spring of 2003 in Houston. I visited Prof. Philip R. Brooks. His laboratory is working on molecular reaction by using crossed beam experiment combined with an electrostatic hexapole field. There is two Ph.D. Student, Beike and Jonathan. I thank them very much for having helped me a lot of things, stay, research and so on. My stay started from Jan.23th and ended up March 16th. Although I spent all time to work in laboratory, I had the opportunity to pay small visit and present my work in Japan. This stay improved my scientific skill as well as communication skill in English.

Picture of me and Beike were taken by Prof. Brooks in LIVESTOCK SHOW

For research, I concerned mainly on the transfer of an electron in chemical reaction in order to carry out the control of chemical reactions. The transfer of an electron from one atom to another molecule plays a fundamental role in forming chemical bonds. Evidence of electron transfer is most striking in the condensed phase where charged species are well-known in electrolytic cells and oxidation-reduction reactions. In this time, we tried to investigate the transfer of an electron through the reaction of sodium(Na) with acetonitrile(CH_3CN) by crossed beam experiment. The steric effect and collision-energy dependence were measured directly using a hexapole and charge exchange method. This experiment could realize the mechanism of the transfer of an electron in detail. The orientation of acetnitrile was controlled by hexapole before collision with sodium which velocity was changed from 5 to 18 eV. Products of this reaction were detected by coincidence-TOF technique. Main product was CN anion (m/e=26) in this reaction. Figure1 shows the steric factor G[1] of CN anion which represents the orientation dependence of this reaction. The steric factor G is expressed as follows.

$$G = \frac{\sigma_i^{TA}(E) - \sigma_i^{ST}(E)}{\sigma_i^{TA}(E) + \sigma_i^{ST}(E)} \qquad (1)$$

where $\sigma_i^{TA}(E)$ and $\sigma_i^{ST}(E)$ are the orientation- and energy-dependent cross section when sodium attack at CN-end and Methyl-end respectively. Form this results, it was found that CN anion was mainly produced by attack at the CN-end. This result indicated that the electron is apparently transferred into the low lying π^*_{CN} orbital and the intermediate Π state undergoes predissociation or a collision-induced crossing to the Σ state. This process is expected to be more likely for attack of the alkali metal at the CN-end of the molecule.

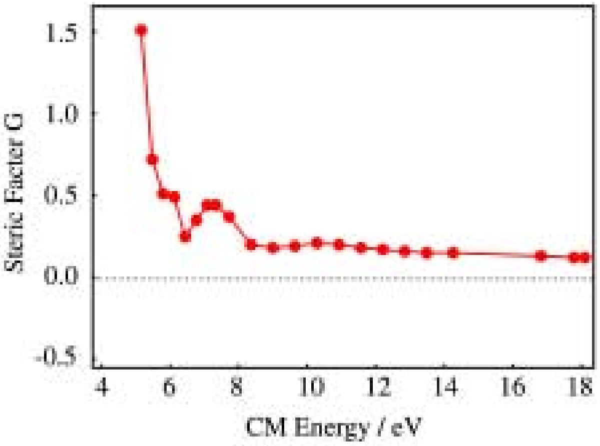

Fig.1 Steric Factor G for CN anion. Positive region of G value correspond to greater reaction probability by attack at CN-end. Negative region of G value correspond to greater reaction probability by attack at the methyl-end

On the other hand, the small signal which appeared around mass number 40 also indicated the orientation dependence. This signal was mainly observed by attack at the methyl-end. However, we have not assigned this peak yet. Now we are investigating this peak using CD_3CN instead of CH_3CN.

These observed data could enable us to know the possibility to control chemical reactions by an electrostatic hexapole field.

Closing this paper, I can repeat, thank you very much again to all the people who I mention above and all kindness of a lot of people in and around Rice University. And I gratefully acknowledge financial support from COE program “Creation of Integrated EcoChemistry”. I will surely keep may stay in Houston in very good memory!

Refference

1.Phys.Chem.Chem.Phys., 2, (2000), 781-791, Sean A. Harris et. al.