

Substrate and solvent effects studied in mixed molecular clusters

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Molecular clusters are unique model species enabling studies of bulk and surface processes by vacuum restricted methods. This is of particular importance for the reactions of low-energy electrons, which have extremely short penetration depth in bulk environments. This contribution overviews our recent experiments with low-energy electrons and clusters prepared by different techniques.

First, the deposition of molecules on argon nanoparticles enables the studies of electron induced chemistry of iron pentacarbonyl on the surface [1]. These studies are relevant for the focused electron beam induced deposition - FEBID technique. In this technique, high energy electron beam is used to create 3D metal nanostructures from organometallic precursors. The precursor molecules such as iron pentacarbonyl are known to be easily decomposed by low energy electrons created as a secondary species in the vicinity of the primary electron track. Already at electron energies near 0 eV, dissociative electron attachment leads to an effective loss of one organic ligand from the isolated compound. However, this reaction channel has not been observed in the surface experiments [2]. That was explained by trapping of the DEA reaction products inside the substrate. In our studies substrate is Ar cluster. In the case, the product ions are trapped in the substrate, we can detect the whole mixed cluster in our experiments. We clearly show that this is not the case. Therefore, the interaction with low energy electrons do not occur at all. We discuss the possible reasons in our recent publication [3].

Second, using the gas humidification method, we have been able to prepare single microhydrated molecules of uracil and its analogues that mimic biological conditions. It is believed that dissociative electron attachment to the nucleic acid bases can be the key process in the synergistic action of radiation with halogenated uracils in the concomitant chemoradiation therapy of cancer. Typically, electron attachment to halogen uracils leads to the formation of transient negative ion that dissociates to form Uyl radical or Uyl radical anion, which are highly reactive. Most of the studies so far therefore focus on the stability of the halouracil transient anions. In our recent study [4] we showed that the water environment is very effective in the stabilization of the transient anions and the dissociation is not effective. However, such stabilization results in the effective energy transfer to the solvent. We will show, how electron attachment spectroscopy of sequentially microhydrated halogen uracils can be used for estimation of the energy transferred to the solvent [5].

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References

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