Condensed Matter / Biophysics Seminar

Thursday

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Rm 184 NSH

Recent experimental studies of transient negative ion mediated chemistry and damage occurring in simple molecular solids and dry DNA

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Electrons with energies less than 30 eV, so-called low energy electrons (LEEs), are among the most numerous secondary species generated in condensed matter by ionising radiation and play an important role in the transfer of energy and subsequent radiochemistry [1]. Electrons with energies less than ~15 eV can temporarily bind to atoms and molecules to form compound states, termed transient negative ions (TNIs), which at particular electron energies, modulate electron scattering cross sections, enhancing electronic and vibrational excitation and initiating molecular dissociation via the process of Dissociative Electron Attachment (DEA) [2]. Reactive species generated in such dissociations may contribute to subsequent chemistry and the synthesis of new species. Here we review recent work in which the contribution of resonant (i.e., TNI) processes to the synthesis of new species in electron irradiated molecular solid films is assessed. Measurements (as a function of incident electron energy) of the Electron Stimulated Desorption (ESD) of negative ion fragments from vacuum-deposited films of acetonitrile [3] and methanol [4] have been used to identify the occurrence of DEA and are compared to the formation of stable product species, as detected by Temperature Programmed Desorption (TPD). While for acetonitrile, there exists a strong correlation between the DEA and the production of ethane, contrastingly in methanol, while the ESD yield of anions is dominated by TNIs, there is little correlation to the production of products methoxymethanol (CH_3OCH_2OH) and ethylene glycol ($HOCH_2CH_2OH$). Formation of these two products is instead thought to involve non-resonant excitation of neutral, dissociative electronic states. ESD has also been used to probe the formation of peroxyl radicals ($RCH_{x-1}OO^{\bullet}$) in electron-irradiated, self-assembled monolayer films of DNA [5,6] and various alkanthiols [7] after exposure to gaseous O_2. In both types of target, it is the resonant dissociation of C-H bonds via DEA, that initiates subsequent reactions between $RCH_{x-1}^{\bullet}$ radicals and O_2. In the final section of this talk, I will review recent experimental developments in DNA film preparation [8] and in the assessment of plasmid DNA viability and quantification of complex DNA lesions [9], that are now being applied to better understand the effects electron-induced damage on DNA functionality [10].

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