Organic molecules interacting with amorphous solid water

Amorphous solid water (ASW) offers the possibility to prepare liquid water surface analogues under ultra-high vacuum conditions. This makes it possible to study the interaction of adsorbed molecules with water surfaces by classical surface analytical techniques like MIES (Meta-stable Induced Electron Spectroscopy) and UPS (Ultraviolet Photoelectron Spectroscopy). Particularly the similarities between ASW and the liquid water phase make these kind of investigations interesting not only for atmospheric but also for astrochemistry as ASW films prepared on substrates under ultra-high vacuum conditions can be compared to the ice coated dust particles in the interstellar medium (ISM).

For example acetic acid and benzene can not only be found in planetary atmospheres (e. g. Earth and Saturn) but also in space near star-forming regions. Therefore the results of these kind of experiments about the interaction between small organic molecules with amorphous solid water surfaces or water molecules in general can be seen as the first step in the understanding of the processes occurring on the surfaces of water-covered dust particles in the Earth atmosphere as well as in the ISM.

By combining the extremely surface-sensitive electron spectroscopy MIES with the vibration spectroscopy RAIRS (Reflection-Absorption Infrared Spectroscopy) and TPD-MS (Temperature-Programmed Desorption Mass Spectroscopy) we were able to get not only information about the molecular orientation of the adsorbed molecules at the ASW-vacuum-interface and the lateral distribution of the species in the adsorbed films but also about the adsorbate-adsorbate and adsorbate-substrate interactions (e.g. H-bonds).

Furthermore the results of these experiments brought not only new insight into this type of interaction but also into our knowledge of ASW and ice itself.

Physicists and chemists are now working for several decades on the water and ice topic, but no group ever came up with an high resolution microscopy image of the ice surface, therefore the main results for interactions of molecules with these kind of surfaces, like adsorption sites, orientations and so on, stems on spectroscopy investigations only.

Dr. Stephan Bahr
Department of Physics
University of Osnabrück
Barbarastr. 7
49076 Osnabrück
Germany