Water Interactions with Organic Surfaces Studied with the Environmental Molecular Beam Method

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Interactions between water and organic surfaces are of central importance in many system processes on Earth including aerosol particle formation and growth. A knowledge gap still exists in the understanding of these processes on a molecular level; hence, we need suitable experimental methods that can access information about molecular interactions.

In this study, we present improvements made to the Environmental Molecular Beam (EMB) method (Kong *et al.*, 2014), which is a technique that enables molecular level studies of interactions between gases and volatile surfaces at near ambient pressure. The EMB method utilizes a molecular beam directed through vacuum onto a surface in a high-pressure chamber, where the surface substrate can be coated with volatile compounds of interest. The flux of molecules scattered or desorbed from the surface is detected with mass spectrometry. The technique obtains information about molecular collision dynamics, gas accommodation coefficients, residence time, and fraction of thermally desorbed or scattered molecules directed onto the surface. The changes made to the EMB setup were motivated by enabling experiments at higher pressure and temperature than with a previous design, as well as carrying out studies in different directions to the surface normal.

A recent study showed that water uptake on *n*-butanol is strongly affected by surface transformations near the melting temperature of butanol (Papagiannakopoulos *et al.*, 2013). In this study the new EMB setup is applied to investigations of water interactions with solid and liquid butanol layers. Angular distributions of scattered and desorbed water from butanol layers are measured over an extended temperature range. The results show that water molecules are efficiently trapped on both solid and liquid butanol, and trapped molecules either undergo rapid thermal desorption or remain on the surface for milliseconds before evaporation occurs. A fraction of molecules is lost due to diffusion into the butanol bulk. The kinetics of surface and bulk accommodation are discussed including the effects of surface melting near the bulk butanol melting point, and changes in the surface structure of the liquid butanol phase.

Kong, X.R., Thomson, E.S., Papagiannakopoulos, P., Johansson, S.M., and Pettersson, J.B.C., (2014) *J. Phys. Chem. B* **118**, p.13378-13386.

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