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The Quasi-Liquid Layer on ice observed with NEXAFS

Jérôme Gabathuler[1], Yanisha Manoharan[1], Huanyu Yang[1], Anthony Boucly[2], Luca Artiglia[2], Markus Ammann[1], and Thorsten Bartels-Rausch[1]
[1]Surface chemistry, PSI, villigen, Switzerland
[2]LSK, PSI, villigen, Switzerland

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Gabathuler, Y. Manoharan, H. Yang, A. Boucly, A. Luca, M. Ammann, T. Bartels-Rausch

Paul Scherrer Institute, Villigen, Switzerland

As temperature approaches the melting point of ice from below, the hydrogen-bonding network at the air – ice interface evolves from a well-defined hexagonal structure towards more randomly spatialized interactions. The general agreement is that a Quasi-Liquid-Layer (QLL) exists at the surface of the ice, and reports on the thickness of this disordered interfacial layer range from 2 nm to 25 nm at 271 K, depending on the probing technique (atomic force microscopy (AFM), ellipsometry, optical reflectivity, sum-frequency generation (SFG)) [1]. These large differences partly arise from the fact that the different techniques are probing different properties of the interface, and the delicate calibration into the thickness of the QLL contributes greatly to the uncertainty.

We investigate the QLL using Near Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy, as Bluhm and his group did in 2002 [2]. The technique probes Auger electrons emitted upon X-ray absorption, thus, NEXAFS becomes inherently sensitive to the upper few nm of the air-ice interfacial region. This work focuses on the probing depth associated with this method and proposes a comprehensive treatment of the data, to help resolve the discrepancy of current thickness data. The importance of the QLL's thickness comes from its contribution to environmental science as a reservoir for chemical impurities and as a host of chemical reactions with an impact on atmospheric and cryospheric composition.

We will present a first data set of NEXAFS from neat ice between – 40 °C and 0°C acquired at the

ISS endstation at the Swiss Light Source of the Paul Scherrer Institute. Results including error bars will be compared to earlier studies. The preliminary analysis suggests that the interfacial disorder seems to be less pronounced than reported in many earlier studies, very much in agreement with recent SFG [3] and AFM data [4].

Literature References:

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