Studies on Interfacial Water Adsorbed on Mica at Room Temperature using Terahertz Spectroscopy

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***Abstract*—Dielectric properties of a water film formed on mica at room temperature, in equilibrium with water vapor at various relative humidities, was studied using terahertz spectroscopy. Structural and dynamical conditions of the adsorbed water film on mica were changed within airtight enclosure in which relative humidity and temperature could be regulative. In this presentation, we discussed the growth of thin films of interfacial water on mica and the phenomenon related to confinement of water with nanometer scale.**

I. Introduction And Background

Water adsorbed on solid surfaces is omnipresent. Interfacial water almost always fills macroscopic or microscopic contact areas between solid bodies in natural or industrial environment, where it usually comes from the atmosphere [1]. It is well-known that interfacial water plays an important role in many biological [2], chemical [3], and physical [4] processes. Even though it has been studied extensively for hundreds of years, knowledge of the structural and dynamical properties of water between interfaces has not yet reached the same degree of sophistication that has been attained for bulk water because of the experimental difficulties in investigating liquid interfaces, in general.

According to recent studies obtained by well-defined optical and non-optical techniques for exploring interfacial liquid, in many processes, interfacial water in confined environments on a nanometer length scale does not exist in its bulk form. That is, it shows many dynamical properties drastically differing from those of bulk water. For example, the effective viscosity of the thin interfacial water in confinement takes values within a factor of nearly three of the viscosity of bulk water [5]. When interfacial water is more compactly confined within three dimensional nanometer-scale volumes with an anisotropic symmetry, its effective viscosity dramatically increases to 7 orders of magnitude greater than that of bulk water at room temperature [6]. For this anisotropically nanoconfined water, a nonlinear viscoelastic behavior remarkably similar to that widely observed in metastable complex fluids was also observed [7]. In addition, it is observed that the response time scale in dynamics is much slower than that of bulk water in both anisotropically [7] and isotropically [8] confined nanoscopic waters.

In the terahertz frequency region, bulk water exhibits a strong absorption which is known to be dominated by intermolecular interactions due to permanent and induced dipole moments in the hydrogen bonded network of water molecules. Although the dielectric properties of water in confinement have been studied at gigahertz frequencies [9], the terahertz spectral range, where the collective modes of liquids are most evident, has not been explored. Very interestingly, in recent years, however, it is observed that three dimensionally and isotropically confined nanoscopic water exhibits resonant absorption properties depending on its size in the terahertz frequency range (or the far-infrared range) [10].

According to previous works, it can be expect that interfacial water film in confinement with the thickness smaller than 10 nm does not behave as bulk water [11] in the terahertz frequency range [12, 13]. However, there are still challenges associated with dielectric properties of this interfacial water film in confinement.

In this presentation, dielectric properties of interfacial water adsorbed on mica at room temperature have been examined as a function of environmental relative humidity in the terahertz frequency range. To control the structural and dynamical conditions for interfacial water formed on mica, compact airtight enclosure in which relative humidity and temperature could be adjustable was used.

II. Results

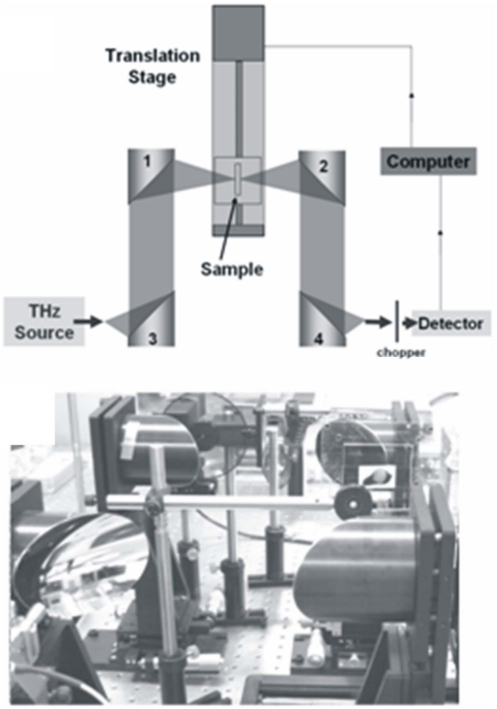

Fig. 1 Schematic and picture of system for terahertz spectroscopy.

The details will be presented at the conference.

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