Analytica Acta-2013

OMICS Group Conferences
Accelerating Scientific Discovery

4th International Conference and Exhibition on
Analytical & Bioanalytical Techniques

October 15-17, 2013 Las Vegas, NV, USA

Femtosecond time-resolved mass spectrometry for the desorption process of tetracene ions from tetracene-doped anthracene crystals

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Abstract

Matrix-assisted laser desorption/ionization (MALDI) is one of the "soft ionization" methods which do not decompose analyte during ionization process. MALDI combined with time-of-flight mass spectrometry (MALDI-MS) has been widely used in many research fields since it enables observation of analyte ions in terms of their molecular weights. Regardless of voluminous applications in MALDI-MS, the mechanism of MALDI is not fully understood. MALDI includes two important processes; ionization and desorption. Although knowledge of the ionization process in MALDI has accumulated by several efforts [1], the mechanism of desorption process remains unclear. This hinders the detection of many kinds of molecules by this method. In this study, we have investigated desorption dynamics by using newly developed femtosecond time-resolved mass spectrometry.

To simplify the roles of matrix and analyte, tetracene-doped anthracene crystals (TDA), in which efficient energy transfer from anthracene to tetracene occurs, were used as a model system and the desorption dynamics of tetracene ions ($[tetracene]^+$) from the anthracene crystals was observed [2]. The rise time of the peak intensity of tetracene ions is determined 94.7 ps. According to the time-resolved fluorescence study, it was observed that the tetracene molecules are excited to the S_1 state after the 9.4 ps delay of pumping, and the S_1 tetracene can be ionized immediately by the irradiation of time-delayed probe pulses. However, the mass intensity of the tetracene ions grows at 94.7 ps after the pumping, suggesting the observation of the slow desorption of the tetracene ions in the mass spectrum. Our results reveal that desorption of tetracene ions is triggered by the electronic relaxation of anthracene leading to the vibrational excitation of lattice phonon modes in the crystals. The delayed growth of the mass signal implies that the time required for the intermolecular dissociative modes to be excited by the relaxation.

Biography

Tatsuya Fujino, Dr. of sc. from Tokyo Institute of Technology in 1998. He worked as a postdoctoral researcher of Japan Society for the Promotion of Science (JSPS) at Institute of Molecular Science (IMS) 1998-2002 and as a special postdoctoral researcher at RIKEN 2002-2005. Since 2005-till date, he is an associate professor at Tokyo Metropolitan University. He got New Century Award from the Japan Society for Analytical Chemistry (JSAC) in 2006. Best presentation awards from the Spectroscopical Society of Japan (SPSJ) in 2004 and from the Kanto branch of Chemical Society of Japan (CSJ) in 2007.