

Femtomolar detection of polycyclic aromatic hydrocarbons by laser desorption/ionization mass spectrometry using excitation energy transfer from anthracene

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Polycyclic aromatic hydrocarbons (PAHs) are chemical compounds that have two to eight aromatic rings in their structures, and they are typically produced by natural events such as forest fires, volcanic activity, and incomplete combustion of petroleum in industrial activities. Therefore, it is important to develop useful techniques for analyzing PAHs in environments.

In this study, we performed laser desorption/ionization (LDI) mass spectrometry of PAHs using excitation energy transfer from anthracene. PAHs such as perylene and benzopyrene were mixed with plenty of anthracene molecules, and perylene-doped anthracene crystals (PDA) and benzopyrene-doped anthracene crystals (BDA) were prepared. Anthracene molecules are first photoexcited and excitons generated in anthracene are transferred to perylene or benzopyrene molecules to produce the S1 state. Then, the S1 perylene or benzopyrene was excited to be ion by exciton migrated. These PDA and BDA crystals were subjected to laser desorption ionization mass spectrometry using a commercial machine equipped with a N₂ laser. PAHs at amounts on the order of femtomolar could be detected, and this sensitivity is roughly 10³ times higher than that of LDI method in our experimental conditions.

In this method, efficient energy transfer between anthracene and PAHs would be hindered when the produced PDA or BDA crystals possess many defect sites. To confirm this, we carried out mass spectrometry of PDA crystals after the annealing procedure to reduce the number of defect sites. We clarified that the number of defect sites that trap excitons generated in anthracene crystals could be reduced by annealing procedure, by which an efficient energy transfer between anthracene and PAHs become possible.

Biography

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