Proton diffusion measurement of a solid electrolyte for fuel cells with infrared spectroscopy

Correlation between hydrogen bonding and proton diffusion in solid acids

We developed a technique for proton diffusion coefficient measurement under high pressure. The proton diffusion coefficients of cesium hydrogen sulfate ($CsHSO_4$), which is a typical proton conductor, have been measured, changing the hydrogen bond strength by pressure. Microscopic infrared spectra were taken for the sample that formed an in-plane joint between the $CsHSO_4$ and $CsDSO_4$ solids in a high-pressure cell. The mapping of the infrared absorption peak due to deuteron provides a deuteron distribution in the plane. The proton–deuteron mutual diffusion coefficient was determined from the temporal change in the deuteron distribution of the solid at high pressures. The technique can be applied to other solid acids, and would be useful in clarifying a correlation between the hydrogen bonding and the proton diffusion for various crystalline phases of solid-acid type proton conductors.

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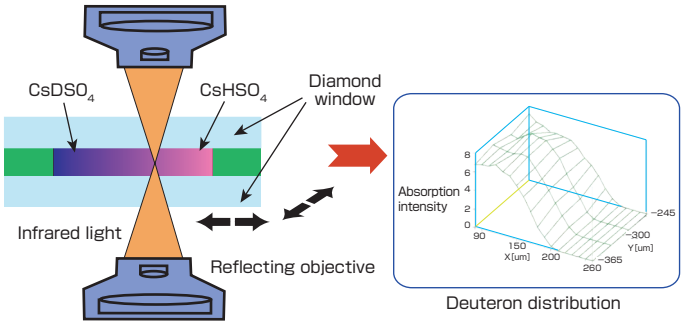
AIST TODAY Vol.8, No.9 p.19 (2008)



Schematic diagram of diffusion measurement with infrared spectroscopy
The proton-deuteron mutual diffusion coefficient was obtained from the temporal change in the O-D distribution in a $CsHSO_4$ / $CsDSO_4$ solid using the infrared mapping measurement.

New mechanism of electron conduction in genomic DNA

Development of observation technique for a conduction electron with attoseconds delocalization time

Conductivity of DNA is a key function for future molecular wires and for understanding the mechanism of detection and repair of damaged DNA related to the process of cancer and aging. We have developed an observation technique for a conduction electron with attoseconds (10^{-18} sec) delocalization time. Delocalization of the conduction electron through the phosphate backbone in DNA was directly probed by the technique which is based on Auger spectroscopy. Results show that ultrafast electron delocalization was observed in genomic DNA with periodic backbones despite separation of each phosphate group by an insulating sugar group. On the other hand, in antisense phosphorotioate DNA with an aperiodic backbone, such delocalization was not observed. Remarkably rapid electron delocalization occurs at ca. 740 attoseconds for wet DNA, as estimated using the core-hole clock method. The delocalization time is comparable to that in electron conductors.

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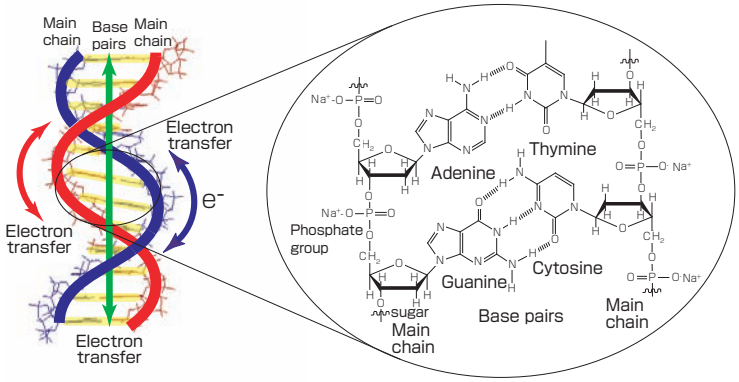
AIST TODAY Vol.8, No.8 p.20 (2008)



Electron conduction mechanism of DNA (red and blue chains are phosphate backbones, yellow sections are base pairs)