Antifreeze protein of high activity produced from a snow mold fungus, *Typhula ishikariensis*

Crystal structure of antifreeze protein from a snow mold fungus

Antifreeze proteins (AFPs) preferentially adsorb to the surface of ice crystals, inhibiting their further growth. It is expected that AFPs can be applied to various industrial uses including frozen food and cold heat transfer. AFP from a psychrophilic fungus, *Typhula ishikariensis* (TisAFP) has been identified to exhibit ice growth inhibition effectively. In the present study, we determined the crystal structure of TisAFP and found that TisAFP is mainly composed of β-helical structure to fold into a semipear-like shape. In contrast to the other hyperactive AFPs with β-helical structures, there were much less repetitive residues aligned on the molecular surface of TisAFP. Site-directed mutational analysis revealed that the ice-binding site of TisAFP is located on the flattest surface of the molecule. In troughs of the ice-binding site there were aligned water molecules which seem to act as anchors for ice-binding. Fluorescence-based ice plane affinity analysis showed that TisAFP binds to both basal and prism planes of ice crystal, different from the other hyperactive AFPs. The unique feature of TisAFP that lacks the regularity in its ice-binding site provides the novel structural insight for hyperactive AFPs.

Sakae TSUDA
s.tsuda@aist.go.jp

Hidemasa KONDO
h.kondo@aist.go.jp

Bioproduction Research Institute

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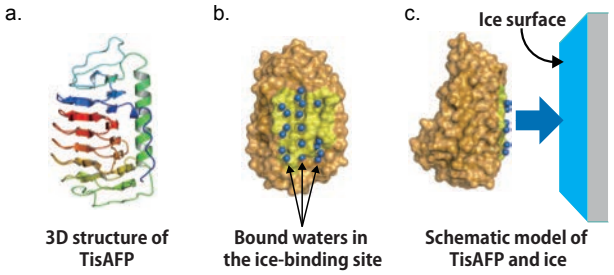

(a) Three-dimensional structure of TisAFP, (b) Molecular surface of TisAFP (The ice-binding site (IBS) is drawn in yellow. Bound waters aligned at the ice-binding site are represented by blue balls.), (c) An illustration representing that TisAFP binds to the ice surface through the IBS

Mott transistor: a novel field effect transistor based on an electronic phase transition

Electrostatic controls of the metal-insulator transition of strongly correlated materials

A Mott transition is a metal-insulator transition characteristic of strongly correlated electronic materials. Mott transistors based on an electrostatic triggering of the Mott transition are believed to surpass the conventional semiconductor FETs because of the vast functionalities and the intrinsically material-independent scaling limit. In this study, we have developed a prototype device of the Mott transistor with a $CaMnO_3$ channel, a typical perovskite-type Mn oxide showing a Mott transition. In order to accumulate a large amount of carriers in the $CaMnO_3$ channel, an electric double layer between the channel and ionic liquid was used for the gate dielectric. Gate voltage as small as 2 V was enough to induce a Mott transition and the insulating $CaMnO_3$ channel changed to the metallic one drastically. Furthermore, gate-voltage dependence of the drain current showed large hysteresis, suggesting a potential application for novel nonvolatile memories.

Akihito SAWA
a.sawa@aist.go.jp

Isao INOUE
i.inoue@aist.go.jp

Electronics and Photonics Research Institute

Shutaro ASANUMA
shutaro-asanuma@aist.go.jp

Innovation Center for Advanced Nanodevices

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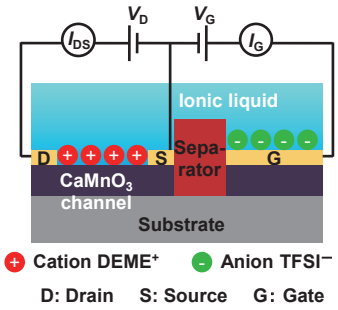
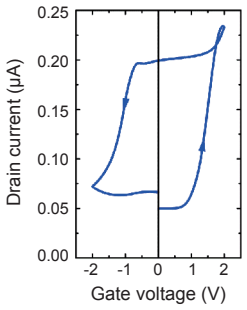


Schematic picture of a Mott transistor consisting of a compressive-strained $CaMnO_3$ thin film and an example of the wiring



Gate-voltage dependence of the drain current in a $CaMnO_3$-channel Mott transistor measured at room temperature