Contribution ID: **199** Type: **Parallel Session Presentation**

Materials chemistry of triplet dynamic nuclear polarization

Tuesday, 19 October 2021 21:40 (20 minutes)

Nuclear magnetic resonance (NMR) spectroscopy and magnetic resonance imaging (MRI) are powerful and versatile methods in modern chemistry and biology fields. Nevertheless, they suffer from intrinsically limited sensitivity due to the low nuclear spin polarization at ambient temperature. One of the promising methods to overcome this limitation is dynamic nuclear polarization (DNP) that transfers spin polarization from electrons to nuclei. In particular, DNP based on photo-excited triplet (triplet-DNP) is promising, since it allows the hyperpolarization at room temperature. In typical scheme of triplet-DNP, the spin-selective intersystem crossing (ISC) produces the large electron spin polarization in the excited triplet state sublevels, and this polarization is effectively transferred to nuclear spins by a pulsed microwave irradiation for satisfying Hartmann-Hahn condition, so-called integrated solid effect (ISE).
While much efforts have been devoted to obtaining the large nuclear polarization based on triplet-DNP, the application of triplet-DNP has been limited to nuclear physics experiments. Towards biological applications, we have proposed to introduce materials chemistry into the field of triplet-DNP, which realizes the hyperpolarization of nanomaterials such as nanoporous metal-organic frameworks (MOFs) and nanocrystal dispersion in water. In addition, we have developed the first examples of air-stable and water-soluble polarizing agents, which allows us to hyperpolarize crystalline ice.

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Session Classification: Applications of Nuclear Polarization in other Fields

Track Classification: Parallel Sessions: Applications of Nuclear Polarization in other Fields