Chirality-Induced Spin Selectivity in an Organic Superconductor

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Chirality-Induced Spin Selectivity (CISS) effect is attracting recent attention as a new source of spin polarized current. Through this effect, chiral molecules can sometimes generate electrical currents whose spins are highly oriented depending on the molecular handedness and the current direction. It also provides unique methods for enantio-separation, enantio-selective electrochemical reactions, and an efficient water oxidation. The mechanism of CISS effect is, however, yet to be clarified, as the effect is much larger than expected one estimated by normal theoretical investigation based on a small spin-orbit coupling for organic molecules. In a hypothetical consideration, it is proposed that an enhancement of spin polarization is based on anti-parallel spin polarizations at two opposite ends of a chiral molecule created in a non-equilibrium condition. It is interesting to note that such an anti-parallel spin pair is time-reversal odd state, while the chiral molecular structure is time-reversal even. We think this type of symmetry conversion gives an essential clue to understand CISS effect that can generate huge spin polarization [1].

In our experiment, we have tried to confirm this hypothesis by using an organic chiral superconductor, which has chiral crystal structure with coherent electrons, under electrical excitation. By measuring spin-dependent interface voltage created at nickel electrodes attached to the chiral superconductor, we have successfully confirmed an enhanced spin accumulation exceeding the expectation from Edelstein effect. Moreover, formation of a pair of antiparallel spin accumulations at two opposite ends of the superconducting crystal was confirmed, which further supported the above hypothesis [2].

References

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