Reversible control of chirality and asymmetric charge transport behavior via an electrochemical approach

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Chirality in materials opens up a wide variety of novel phenomena such as chirality-induced spin selectivity (CISS).[1] However, unlike charge and spin degrees of freedom, it is difficult to control chirality by an external field. This limits the manipulation of chirality-induced functionalities for further applications. Here, we demonstrate the electrochemical intercalation/deintercalation of chiral organic molecular cations (*R*/*S*-Mepy$^+$) for a van der Waals 2D inorganic crystal of MoS_2 to reversibly control the chirality of the system. (Fig. 1a).

In the intercalated material, the shift of X-ray diffraction peaks to a lower 2θ angle was observed, indicating the expansion of interlayer distance. Phonon peaks in Raman spectra and Mo peaks in X-ray photoelectron spectra were both observed to shift to a lower energy. These imply the change of Mo oxidation state due to the electron doping. All these evidences support the successful electrochemical intercalation of *R*/*S*-Mepy$^+$ into MoS_2. Importantly, the CISS is detected with a nearly full spin polarization and its sign reverses depending on the chirality of intercalated cation. Moreover, the intercalation process was reversible for at least 3 cycles (Fig. 1b). This work expands the practicable candidates from limited chiral materials to general 2D materials for the manipulation of chirality and the chirality-induced functionalities via the electrochemical approach.

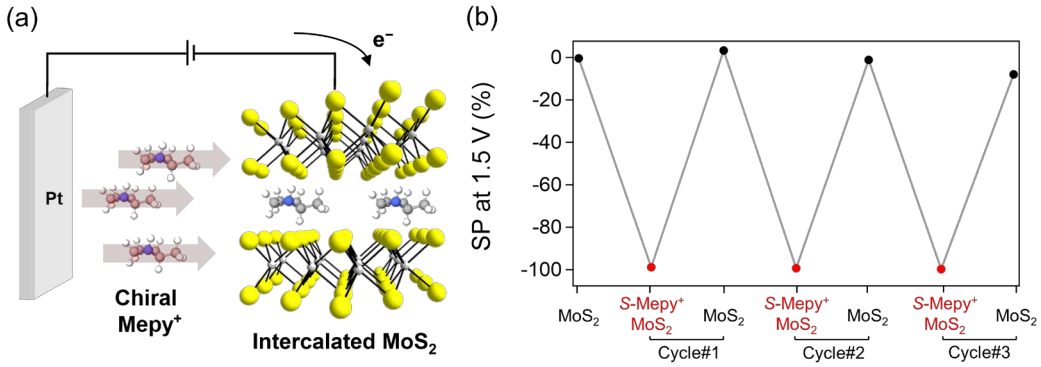

Fig. 1. (a) Schematic of the electrochemical intercalation of chiral molecular cations. (b) Electrochemical control of CISS with a nearly perfect spin polarization (SP).

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