Flat-Band Electronic Bipolarity in a Janus and Kagome van der Waals Semiconductor Nb_3TeI_7

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Janus materials, a novel class of materials with two faces of distinct chemical compositions, have strong potential for various applications with catalytic reaction, chemical sensing, and optical or electronic responses. The key aspect for such functionalities is face-dependent electronic bipolarity, whose strength needs to be maximized but usually set by the chemical distinction of terminated surfaces. Here, we show that in a Janus and Kagome van der Waals (vdW) semiconductor Nb_3TeI_7, strong correlation of inherent flat bands induces strong electronic bipolar states even though only one-fourth of I atoms are replaced by Te atoms in one side of the layers. We observed a large potential difference by ~ 0.7 eV between the I_4 and TeI_3 terminated faces and their corresponding *n*-type and *p*-type field-effect transistor behaviors. This strong out-of-plane polarization is attributed to a built-in electric field due to ferroelectric-like coherent stacking of the Janus layers, amplified by strong electron correlation in the flat bands of Nb *d* electrons at the breathing Kagome lattice. Our findings highlight that the naturally-grown Janus and Kagome vdW semiconductors provide a promising material platform for utilizing strong electronic bipolarity in two-dimensional-material-based applications.