https://doi.org/10.1007/s11467-023-1334-y Front. Phys. 19(1), 23202 (2024)

RESEARCH ARTILCE

Proposal for valleytronic materials: Ferrovalley metal and valley gapless semiconductor

San-Dong Guo[1], Yu-Ling Tao[1], Guangzhao Wang[2], Shaobo Chen[3], Dong Huang[1], Yee Sin Ang[4]

[1]*School of Electronic Engineering, Xi'an University of Posts and Telecommunications, Xi'an 710121, China*

[2]*Key Laboratory of Extraordinary Bond Engineering and Advanced Materials Technology of Chongqing, School of Electronic Information Engineering, Yangtze Normal University, Chongqing 408100, China*

[3]*College of Electronic and Information Engineering, Anshun University, Anshun 561000, China*

[4]*Science, Mathematics and Technology (SMT), Singapore University of Technology and Design (SUTD), 8 Somapah Road, Singapore 487372, Singapore*

Corresponding author. E-mail: [†]*sandongyuwang@163.com*

Received May 20, 2023; accepted July 26, 2023

Supporting Information

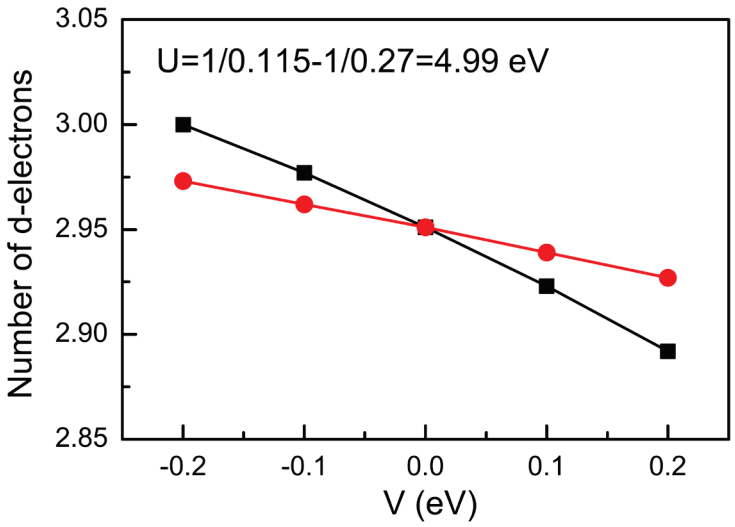

Fig. S1 For $RuBr_2$ monolayer, the number of *d*-electrons as a function of the additional potential *V*.

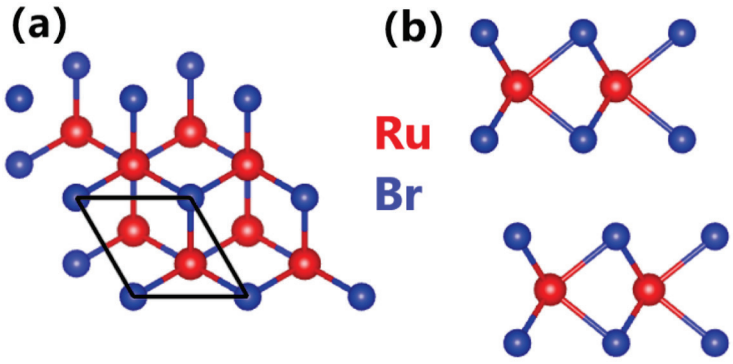

Fig. S2 Crystal structures of AB-stacked bilayer $RuBr_2$: **(a)** top view and **(b)** side view.

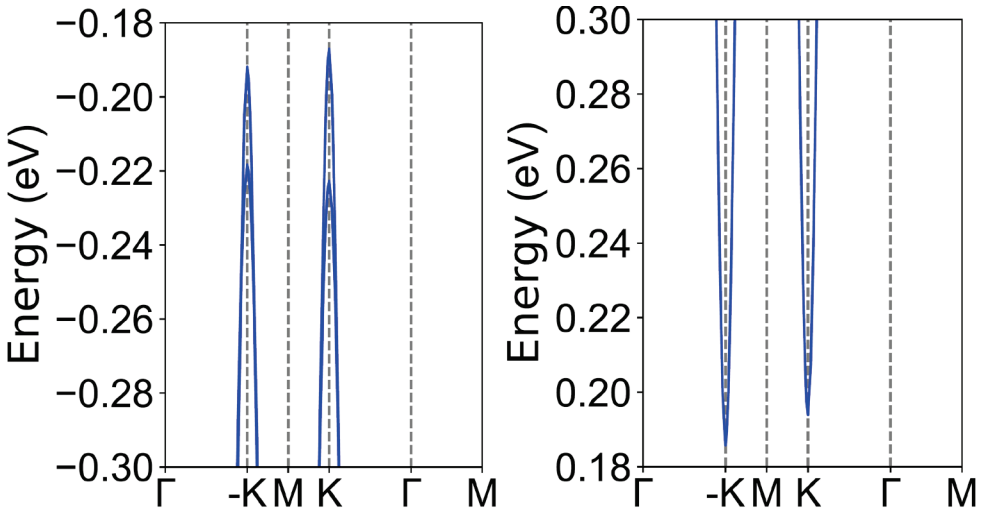

Fig. S3 For AB-stacked bilayer $RuBr_2$, the enlargement in the regions of the band-edge states.

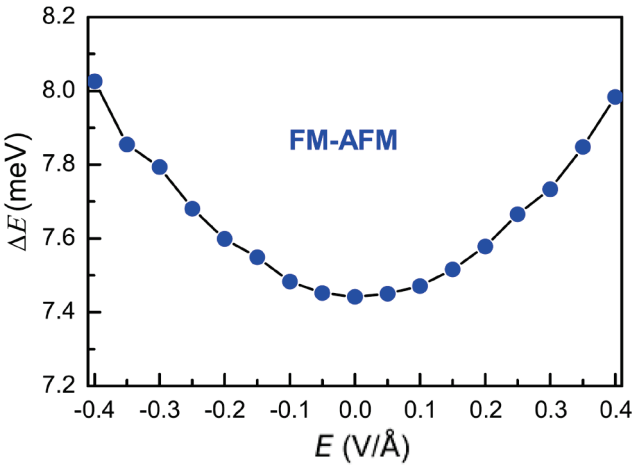

Fig. S4 The energy difference (per Ru atom) between FM and AFM ordering as a function of *E*.

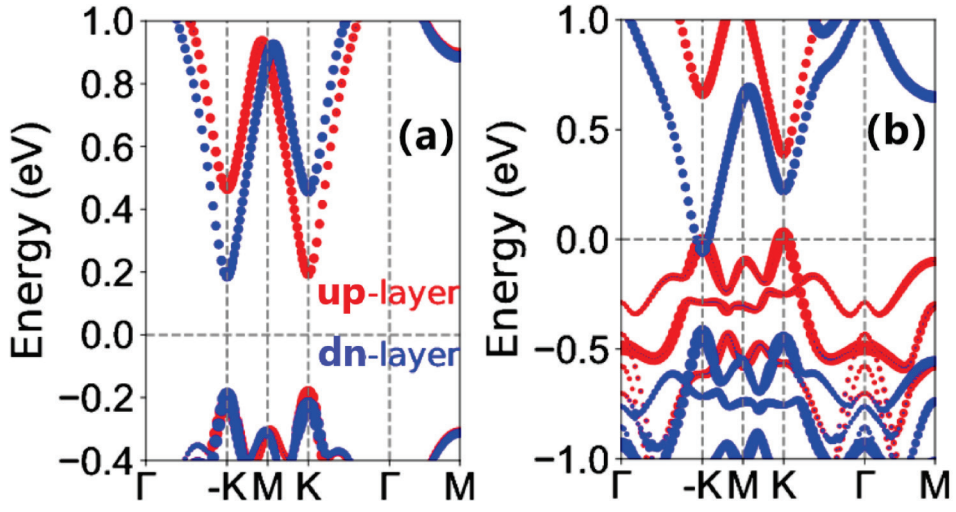

Fig. S5 The layer-characters energy band structures at *E*=0.00 V/Å **(a)** and 0.40 V/Å **(b)**.

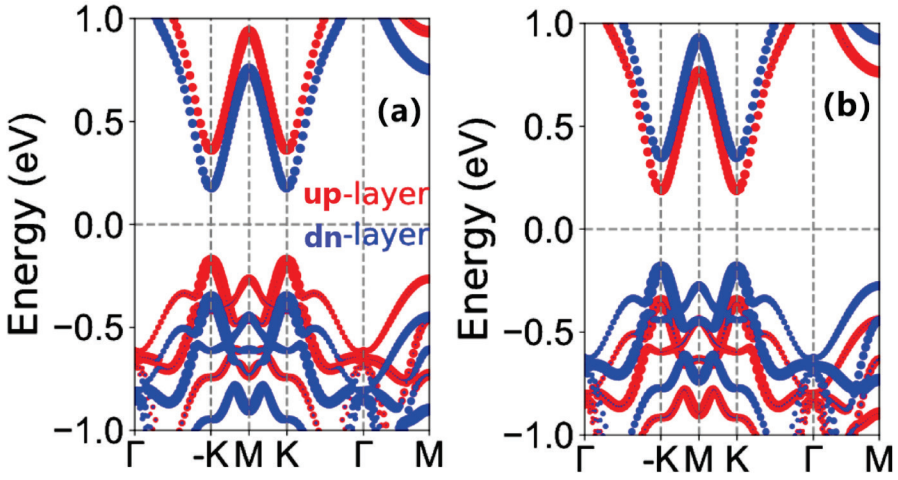

Fig. S6 For in-plane magnetization, the layer-characters energy band structures at E=+0.15 V/Å **(a)** and –0.15 V/Å **(b)**.

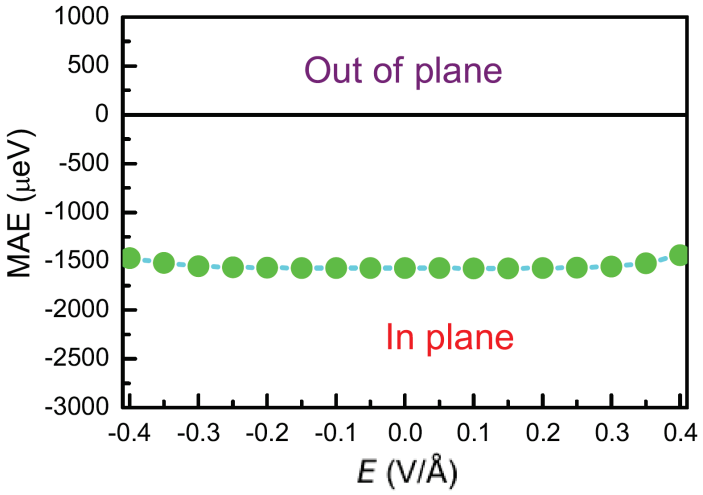

Fig. S7 The MAE (per Ru atom) as a function of E.

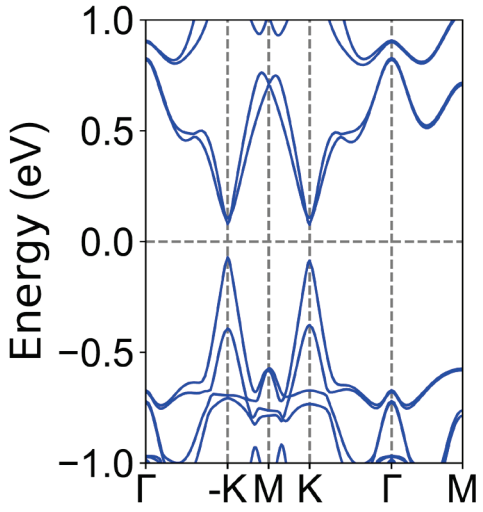

Fig. S8 At $a=a_0$=0.95, the energy band structures of AB-stacked bilayer $RuBr_2$.

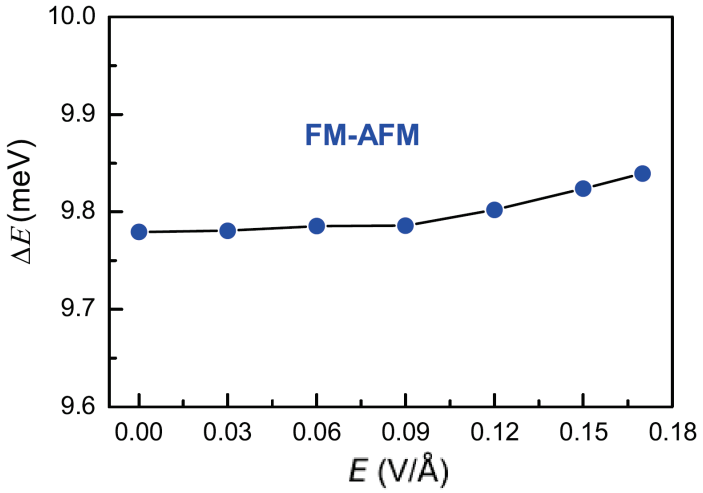

Fig. S9 At a=a0=0.95, the energy difference (per Ru atom) between FM and AFM ordering as a function of E.

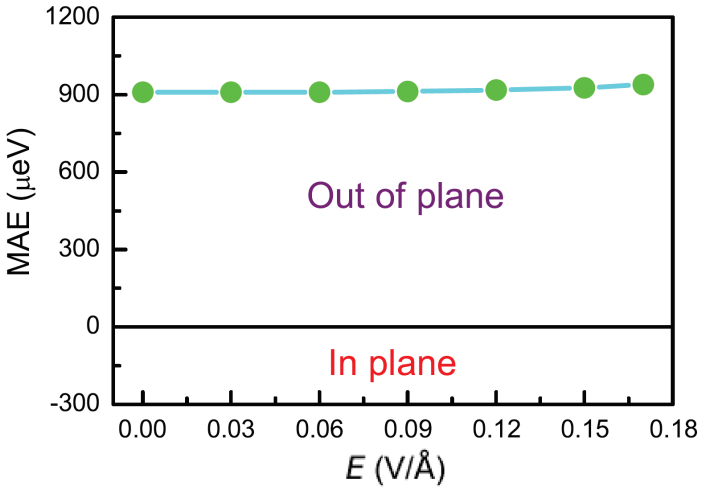

Fig. S10 At a=a_0=0.95, the MAE (per Ru atom) as a function of E.

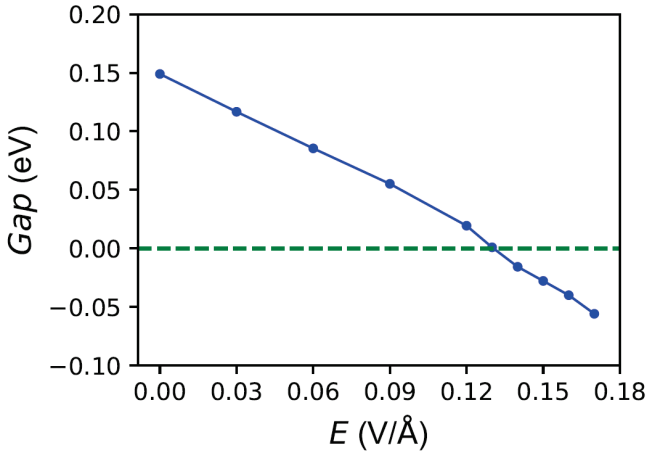

Fig. S11 At a=a_0=0.95, the total gap as a function of E.