Supplementary Material for "Superconductivity with a Violation of Pauli Limit and Evidences for Multigap in η-Carbide type Ti_4Ir_2O"

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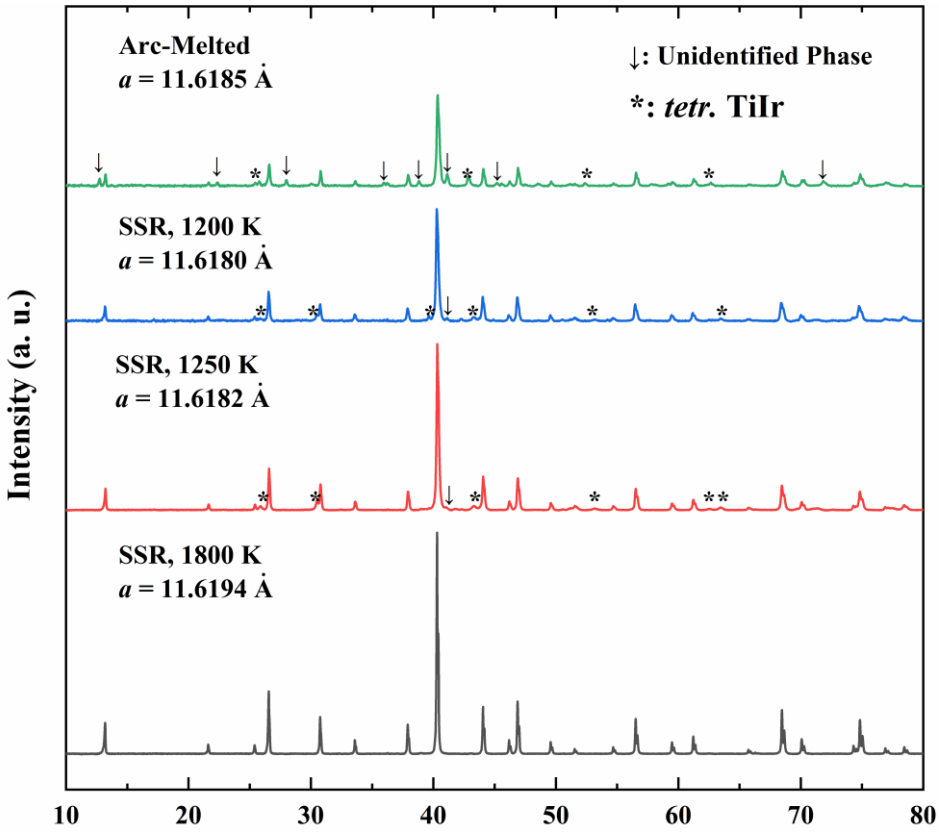

Figure S1: Representative XRD patterns of Ti_4Ir_2O samples prepared with different methods. From bottom to top: SSR (Solid state reaction) at 1800 K, SSR at 1250 K, SSR at 1200 K, and arc-melted samples. SSR at 1800 K produced single-phase sample, while the other three methods produced multi-phase samples. The lattice parameter *a* is slightly different too. *Tetr.* TiIr stands for tetragonal TiIr (space group *P*4/*mmm*). "↓" indicates an unidentified phase.

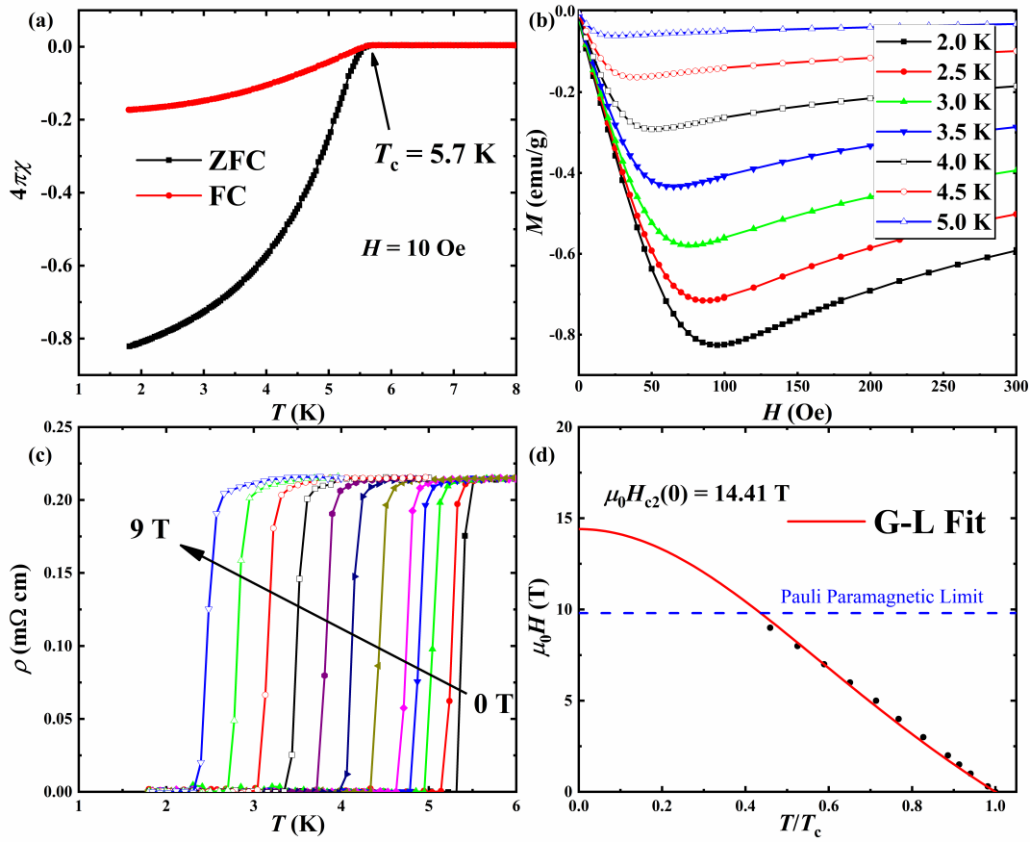

Figure S2: Electrical and magnetic properties of Ti_4Ir_2O prepared by SSR at 1200 K. Notice that although T_c of this sample is somewhat higher than the one shown in the main text, the transition width is larger, and the upper critical field is lower (but still above the Pauli limit), indicating a less good sample quality. (a) DC magnetic susceptibility under 10 Oe from 1.8 K to 8 K. (b) Isothermal magnetization curves at different temperatures. (c) Superconducting transition under different magnetic fields. (d) Upper critical fields at different temperatures, and its fit by G–L relation.

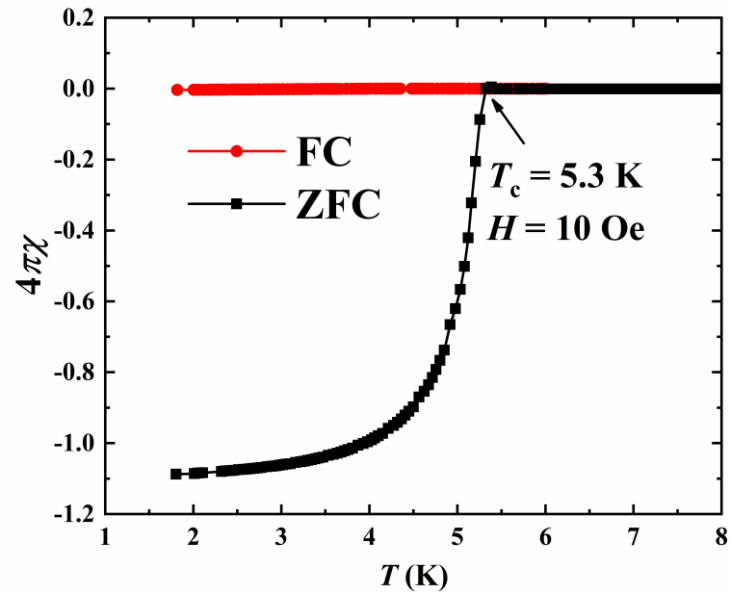

Figure S3: DC magnetic susceptibility of Ti_4Ir_2O prepared by arc-melting method.

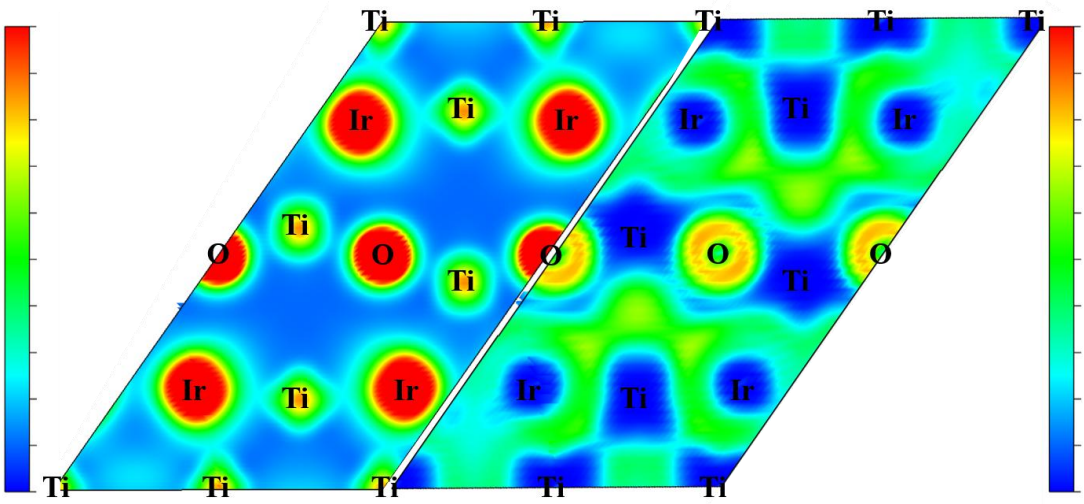

Figure S4: Charge density (left) and electron localization function (ELF) (right) of Ti_4Ir_2O calculated with SOC. The charge density is bound between 0 and 0.2 e/a_0^3 (a_0 is the Bohr radius), while ELF is bound between 0 and 1.

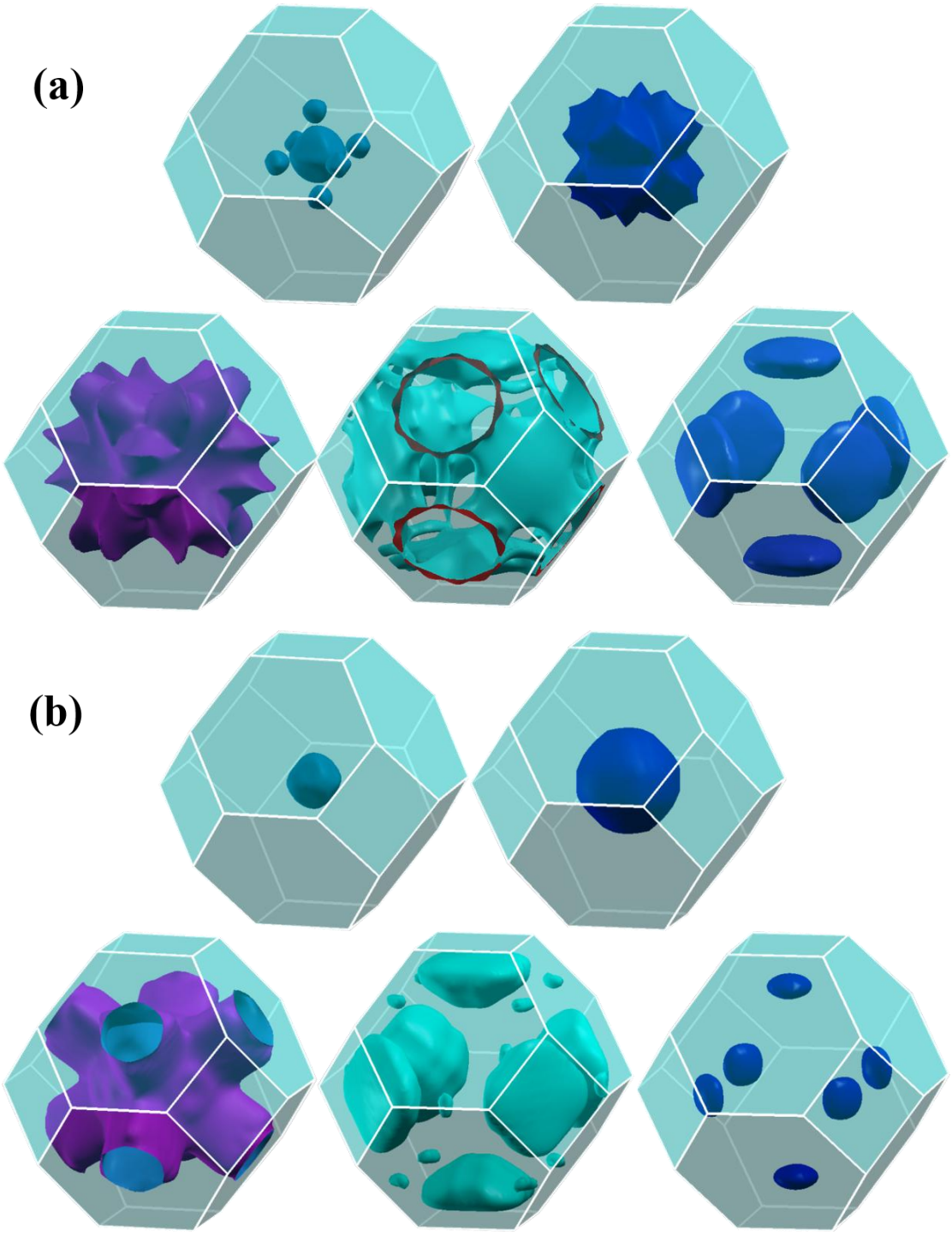

Figure S5: Fermi surfaces of Ti_4Ir_2O (a) without SOC and (b) with SOC.