Supporting Information

Layer-controlled evolution of electron state in the silicene intercalation compound $SrSi_2$

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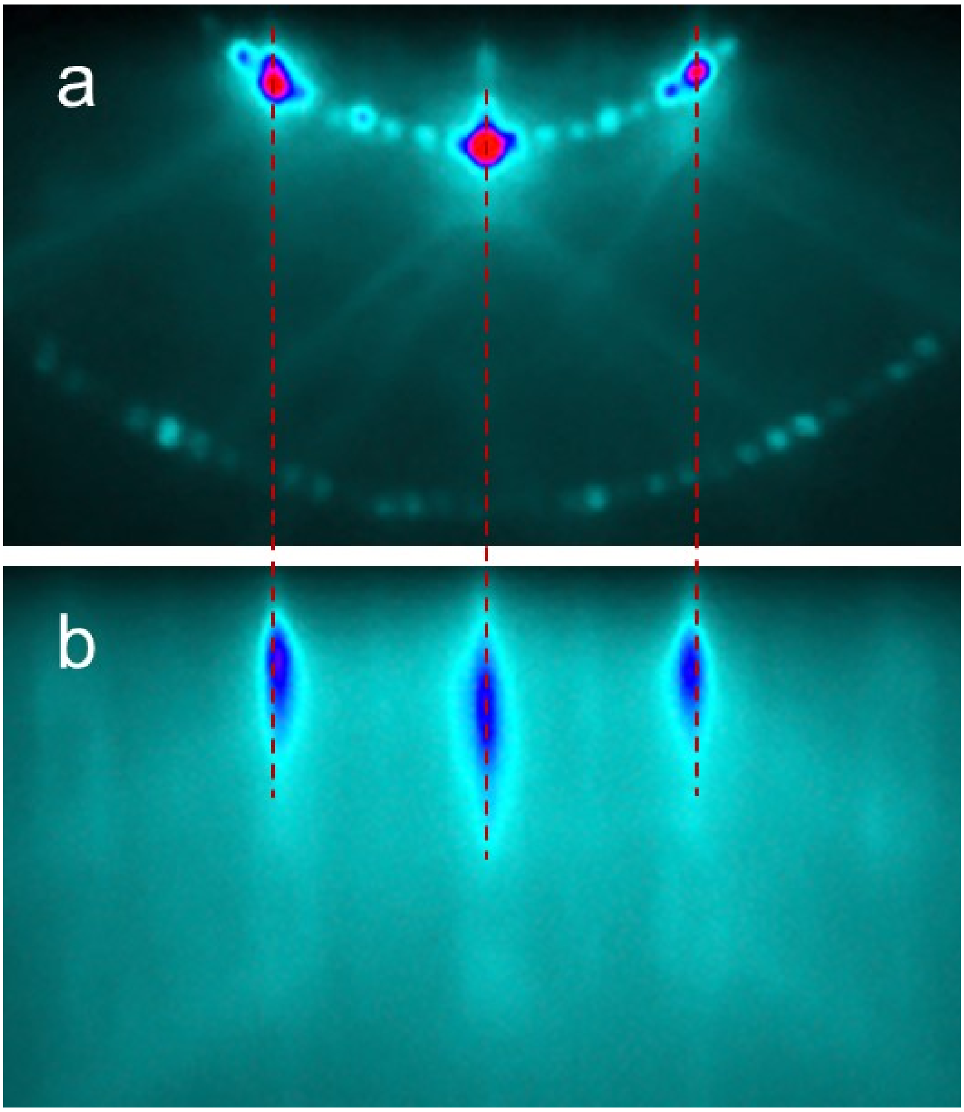

Figure S1. RHEED images along the $[1\bar{1}0]$ azimuth of the Si substrate. a) Reconstructed Si(111) surface. b) A film of $SrSi_2$ (d = 160 nm). The lattice match between the lateral lattice parameters of Si(111) and $SrSi_2$ is highlighted by red dashed lines.

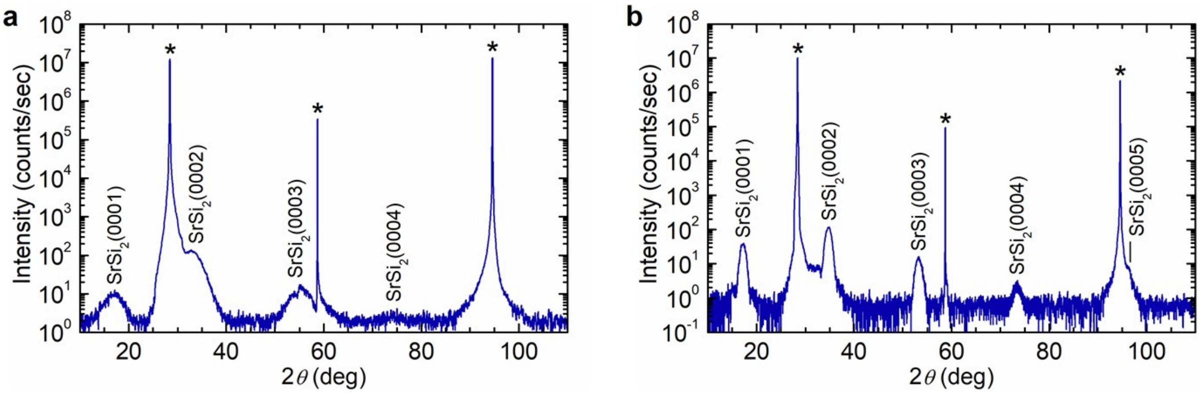

Figure S2. θ-2θ XRD scans of ultrathin $SrSi_2$ films (the θ angles are scaled to the Cu $K_{\alpha 1}$ wavelength to facilitate comparison with Fig. 1c): a) 3 ML and b) 8 ML; asterisks mark peaks from the substrate.

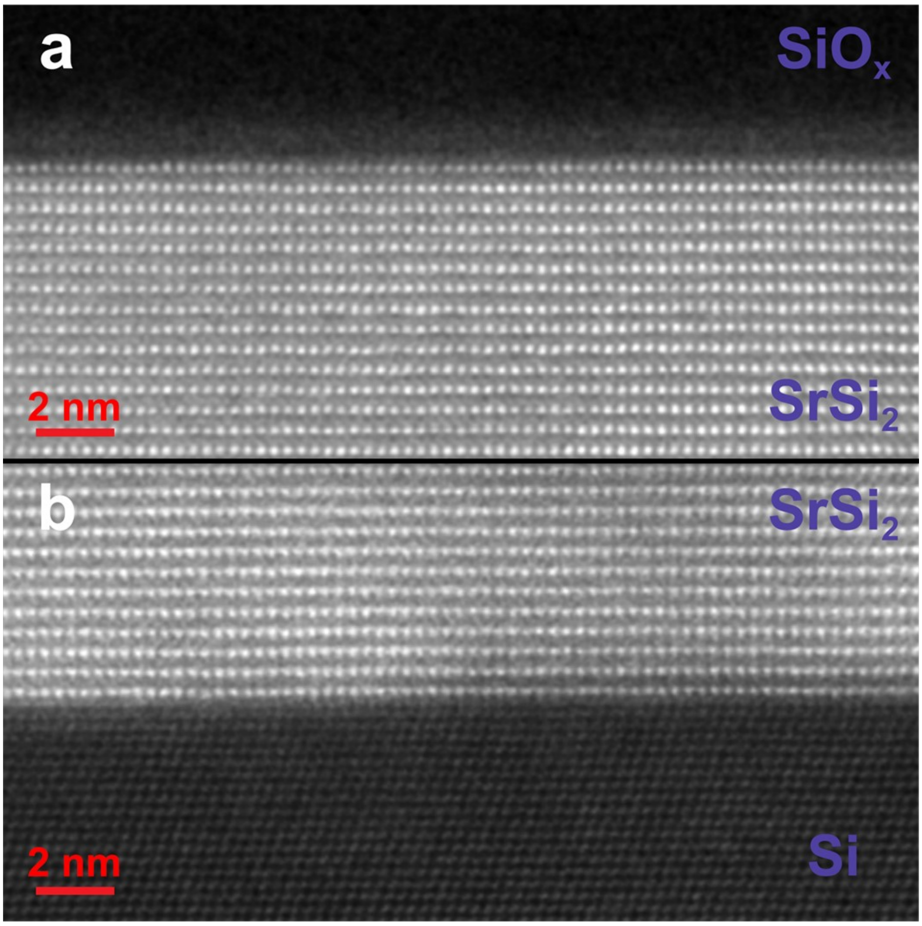

Figure S3. Cross-sectional HAADF-STEM images of interfaces in $SiO_x/SrSi_2/Si(111)$: a) the $SiO_x/SrSi_2$ interface; b) the $SrSi_2/Si(111)$ interface. Both images are viewed along the [110] zone axis of the Si substrate.

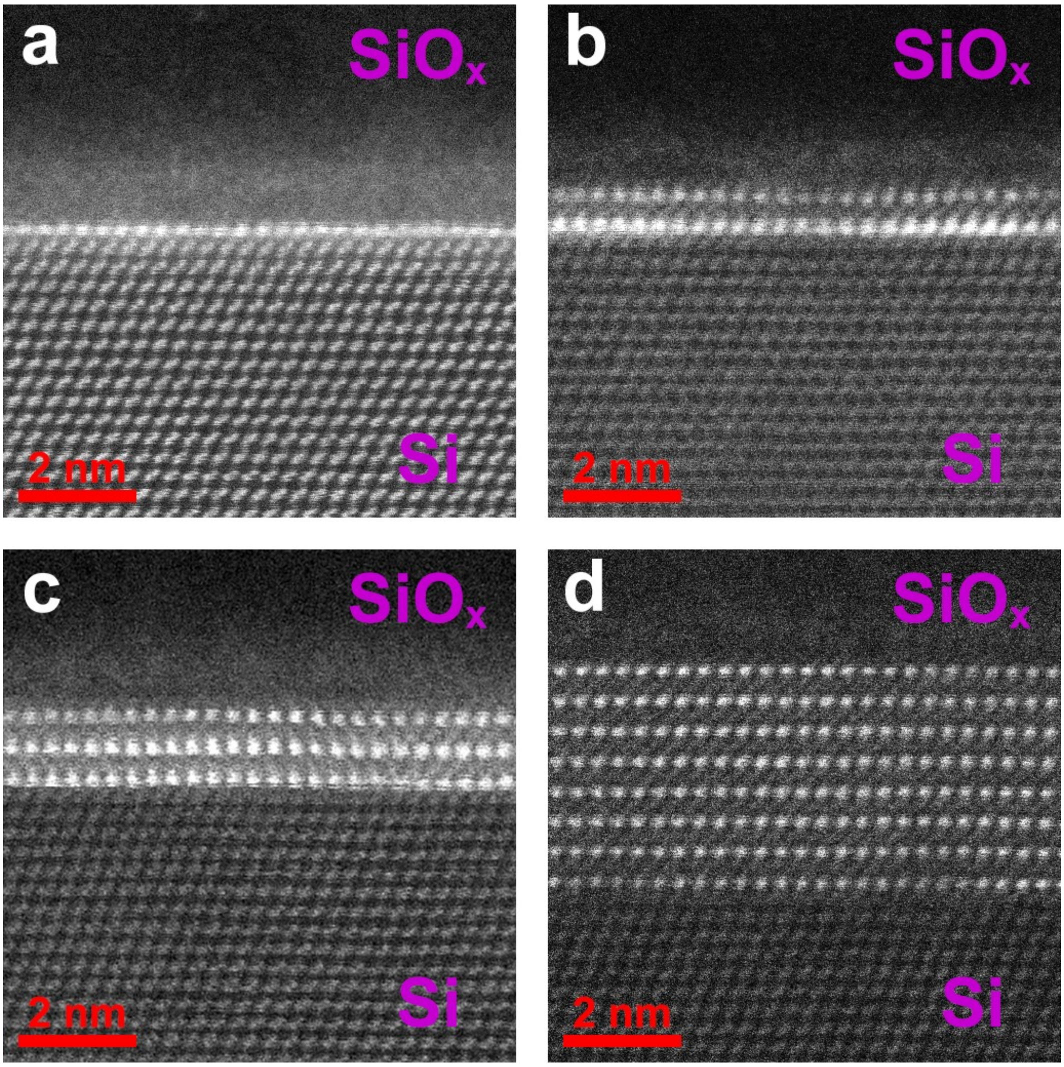

Figure S4. Cross-sectional HAADF-STEM images of ultrathin $SrSi_2$ films on Si(111): a) 1 ML; b) 2 ML; c) 3 ML; d) 8 ML. The images are viewed along the [110] zone axis of the Si substrate. Bright points correspond to Sr atoms.

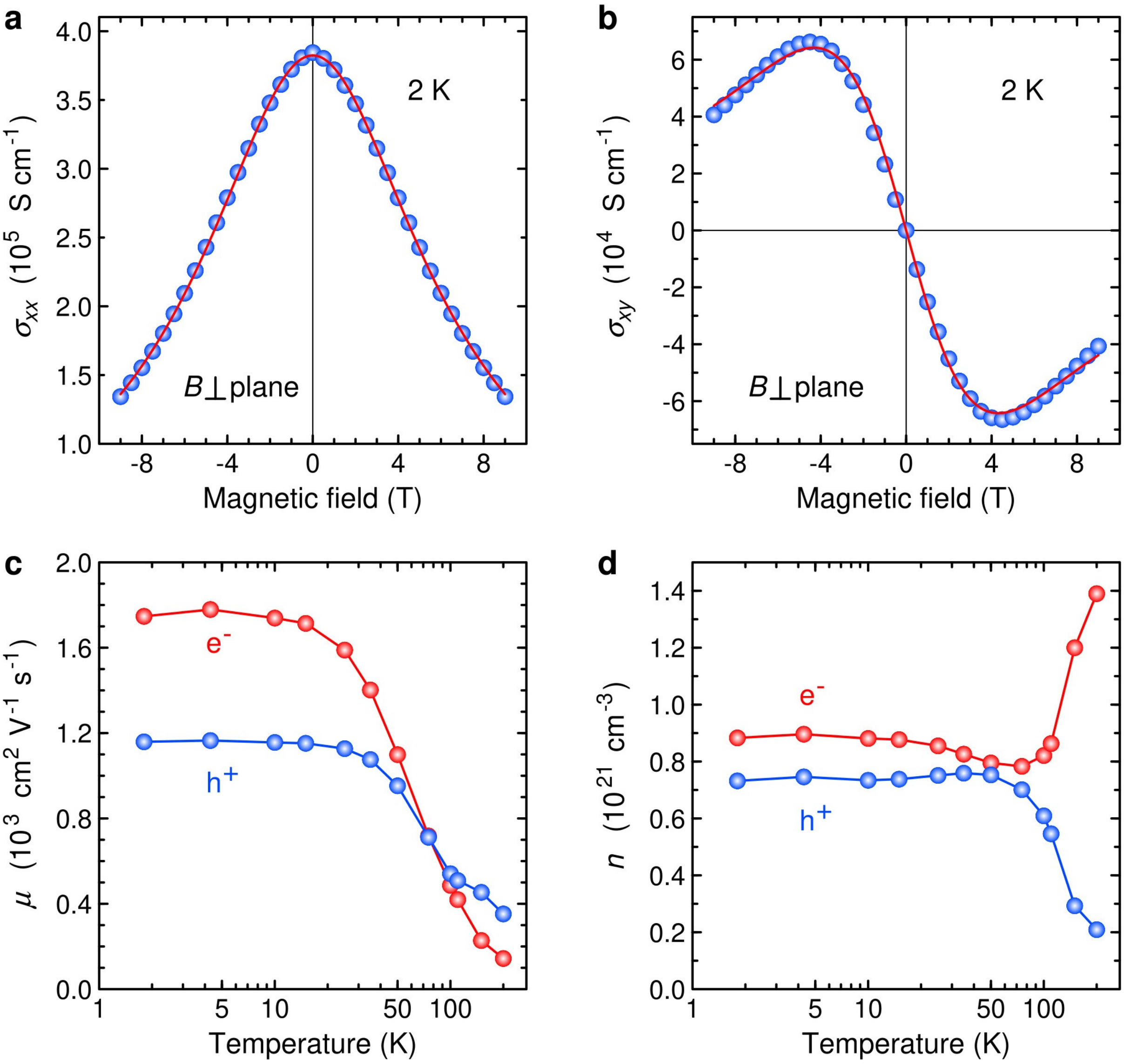

Figure S5. Electron transport in a thick $SrSi_2$ film (d = 160 nm). a) Longitudinal and b) transverse conductance at 2 K in out-of-plane magnetic field; red lines provide fits of the data by a two-band model. Temperature dependence of c) carrier mobility and d) carrier concentration for the electron (red) and hole (blue) bands.

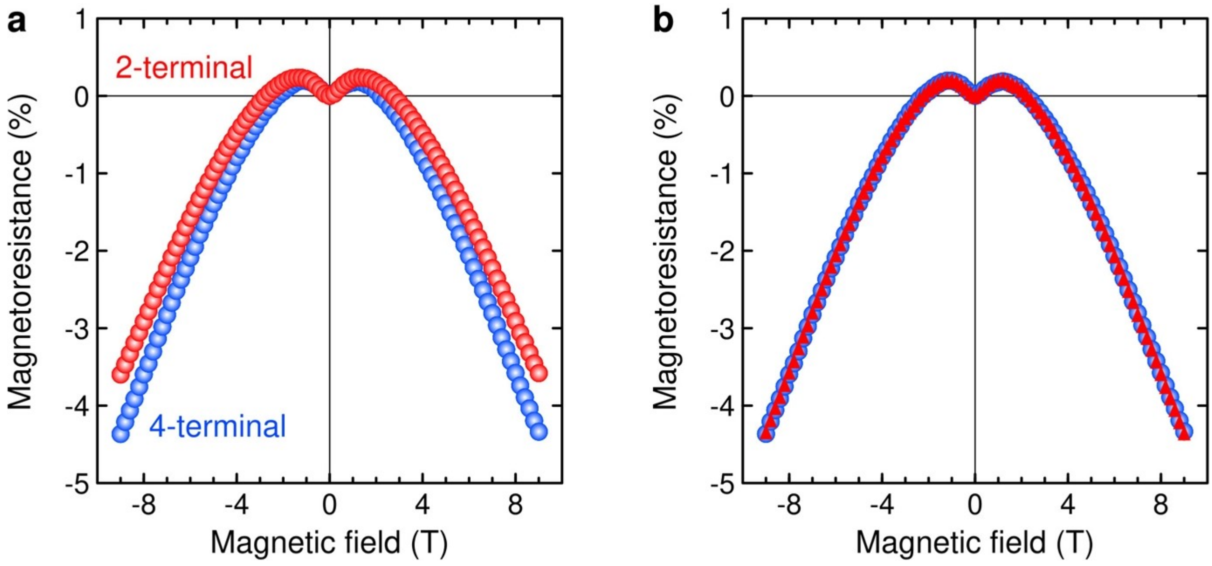

Figure S6. Electrical scheme dependence of magnetoresistance of a thick $SrSi_2$ film (d = 160 nm) at 2 K in magnetic field parallel to the current: a) 2-terminal (red) vs. 4-terminal (blue); b) interchange of potential and current contacts.

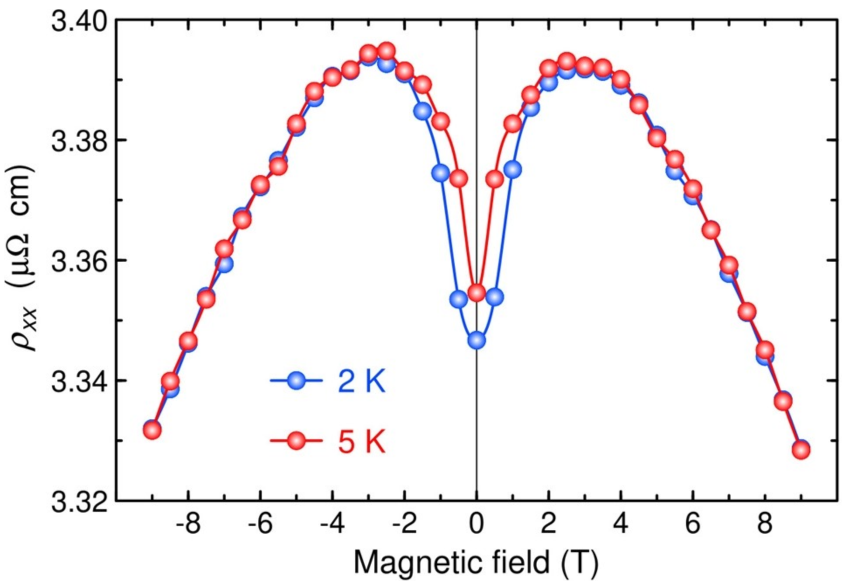

Figure S7. Resistivity of a thick $SrSi_2$ film (d = 160 nm) at T = 2 K (blue) and T = 5 K (red) in magnetic field parallel to the current.

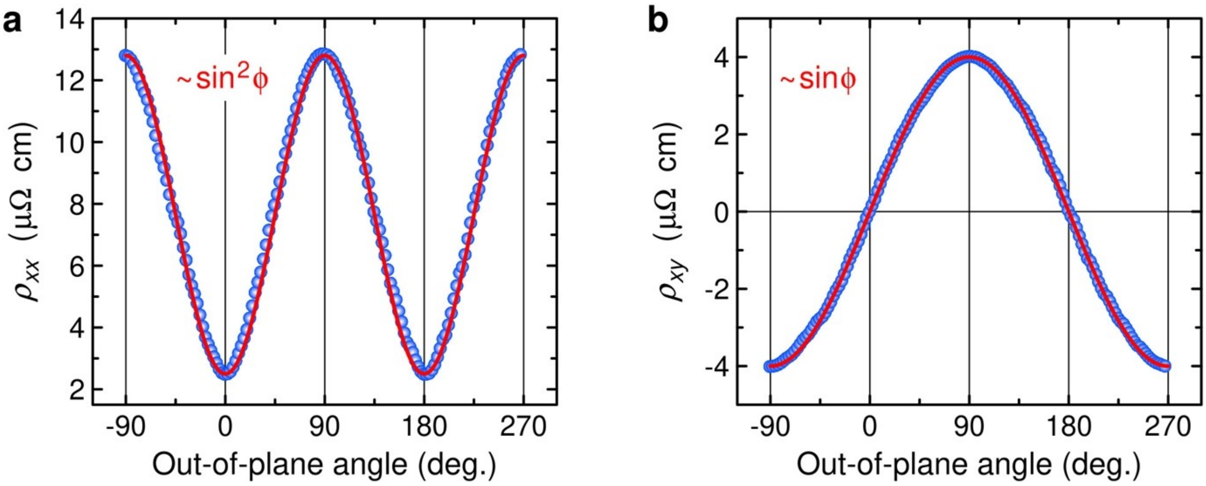

Figure S8. Dependence of a) longitudinal and b) transverse resistivity in a thick $SrSi_2$ film (d = 160 nm) at T = 2 K on the angle ϕ between an out-of-plane magnetic field (with in-plane projection along the current direction) of 14 T and the current direction (blue dots) and their respective fits as $const \cdot sin^2\phi$ and $const \cdot sin\phi$ (red lines).

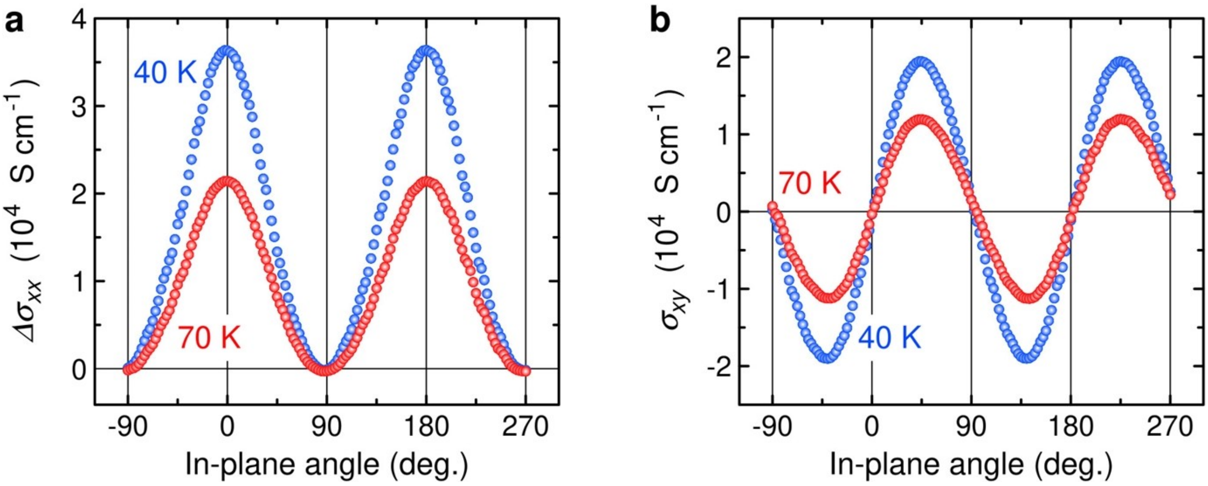

Figure S9. Dependence of a) longitudinal and b) transverse conductivity in a thick $SrSi_2$ film (d = 160 nm) at 40 K (blue) and 70 K (red) on the angle θ between an in-plane magnetic field of 14 T and the current direction.

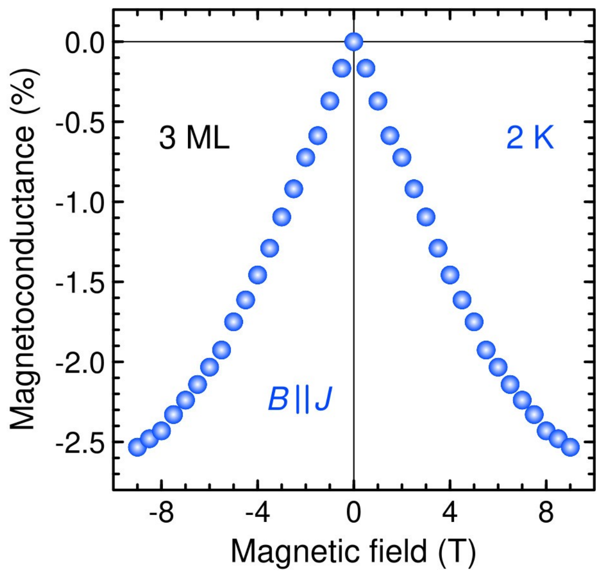

Figure S10. Magnetoconductance in 3 ML $SrSi_2$ at $T = 2$ K in magnetic field parallel to the current.

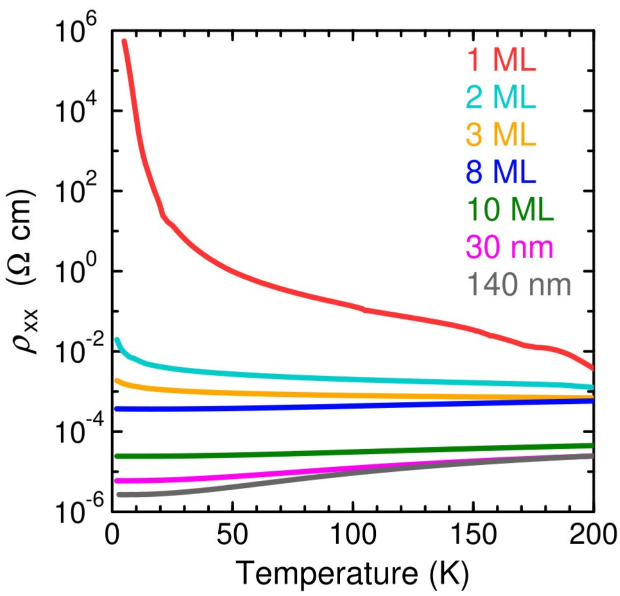

Figure S11. Temperature dependence of resistivity in $SrSi_2$ films of different thickness: 1 ML (red), 2 ML (cyan), 3 ML (orange), 8 ML (blue), 10 ML (green), 30 nm (magenta), and 140 nm (grey).

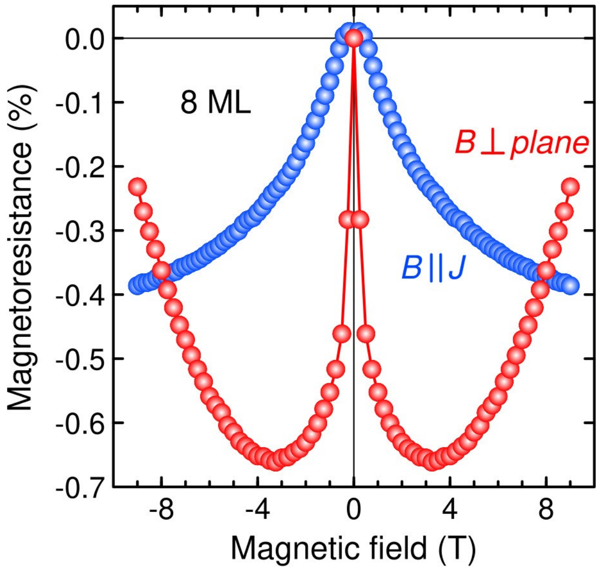

Figure S12. Magnetoresistance of 8 ML $SrSi_2$ at $T = 2$ K in magnetic fields directed in-plane (parallel to the current, blue) and out-of-plane (red).

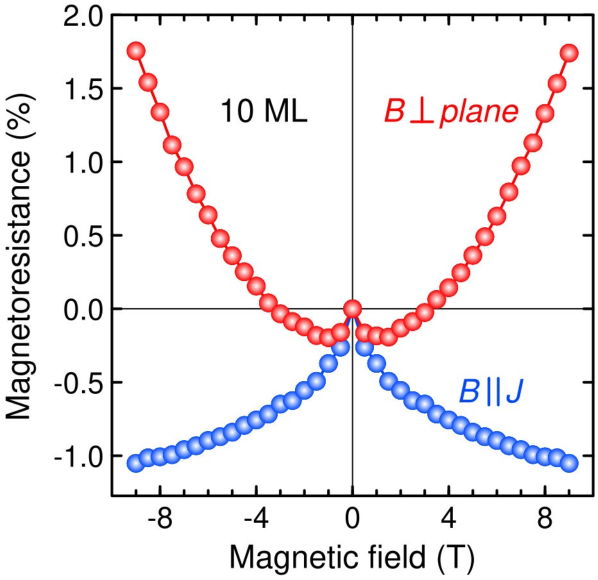

Figure S13. Magnetoresistance of 10 ML $SrSi_2$ at $T = 2$ K in magnetic fields directed in-plane (parallel to the current, blue) and out-of-plane (red).

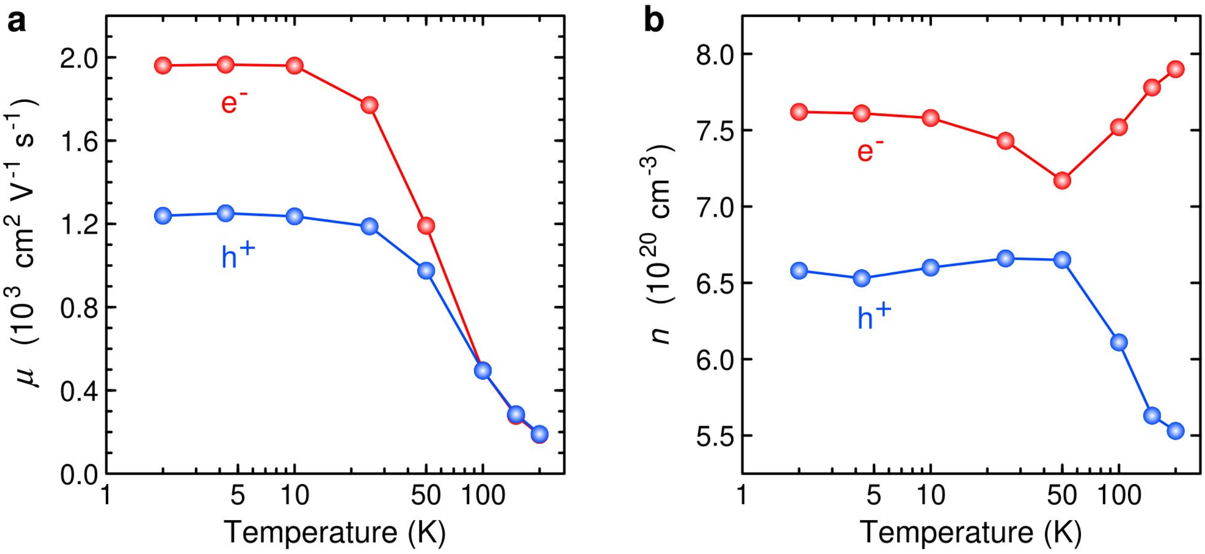

Figure S14. Temperature dependence of a) carrier mobility and b) carrier concentration for electrons (red) and holes (blue) in 140 nm $SrSi_2$.

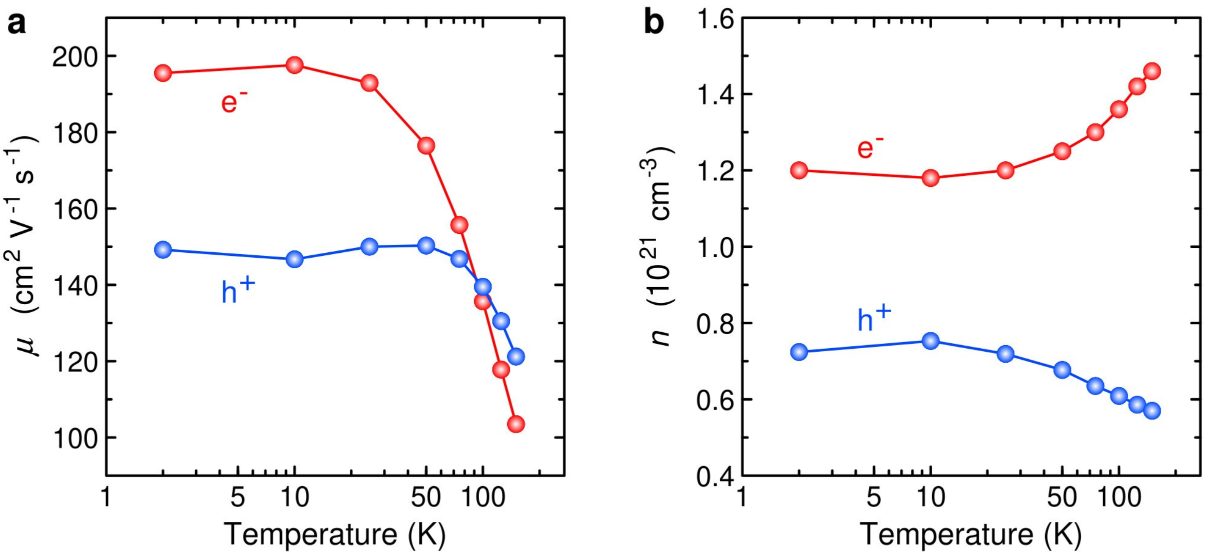

Figure S15. Temperature dependence of a) carrier mobility and b) carrier concentration for electrons (red) and holes (blue) in 10 ML $SrSi_2$.

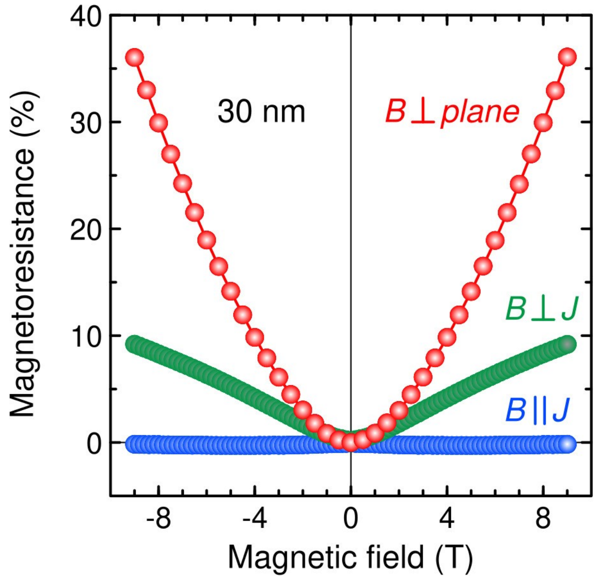

Figure S16. Magnetoresistance of 30 nm $SrSi_2$ at $T = 2$ K in in-plane magnetic field, parallel (blue) and orthogonal (green) to the current, and out-of-plane magnetic fields (red).

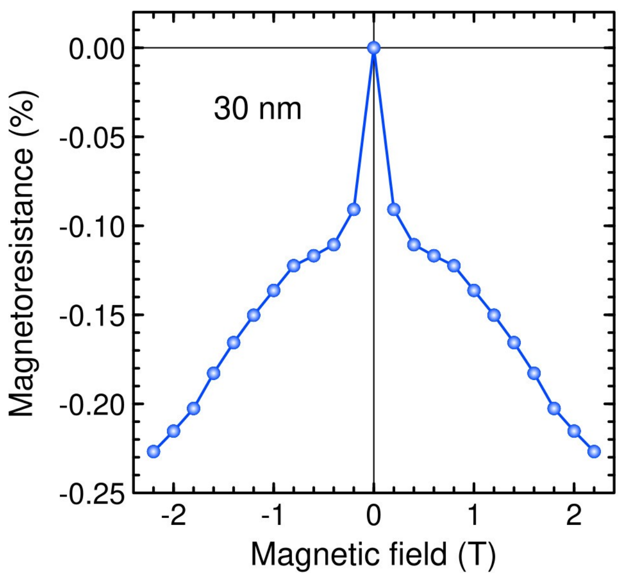

Figure S17. Magnetoresistance of a $SrSi_2$ film ($d = 30$ nm) at $T = 2$ K in magnetic field parallel to the current.

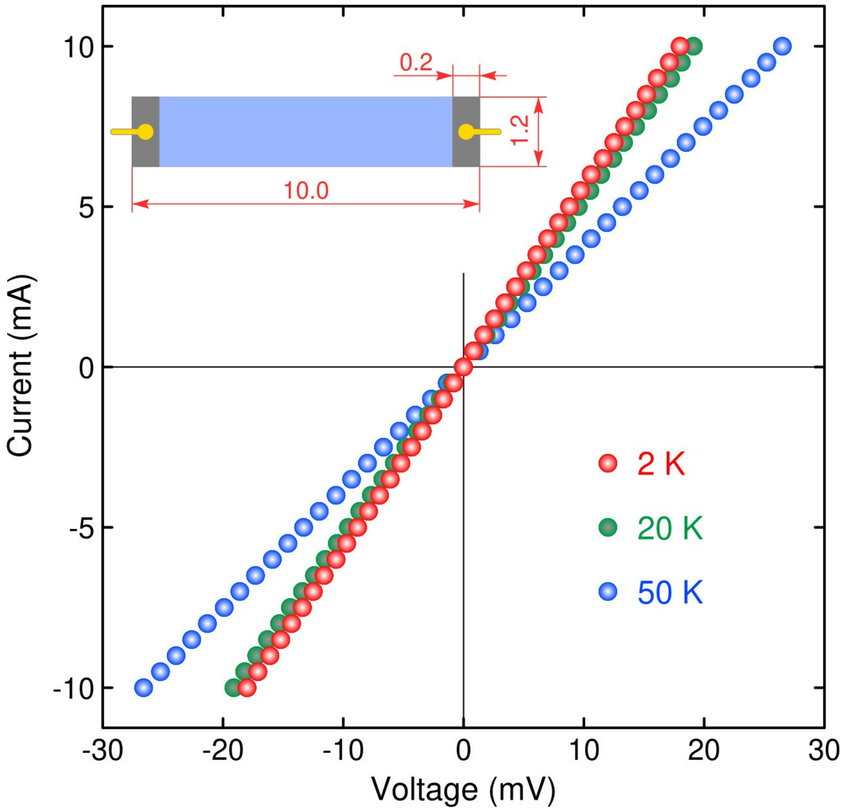

Figure S18. Two-terminal measurements of I-V characteristics in a thick $SrSi_2$ film (d = 160 nm) at 2 K (red), 20 K (green), and 50 K (blue) demonstrating an ohmic behavior. Inset shows a scheme of the measurements – the sample (blue) and the contact areas (grey); the distances are given in mm.