Stabilization of lead-free bulk $CsSnI_3$ perovskite thermoelectrics via incorporating TiS_3 nanoribbon clusters

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XRD data

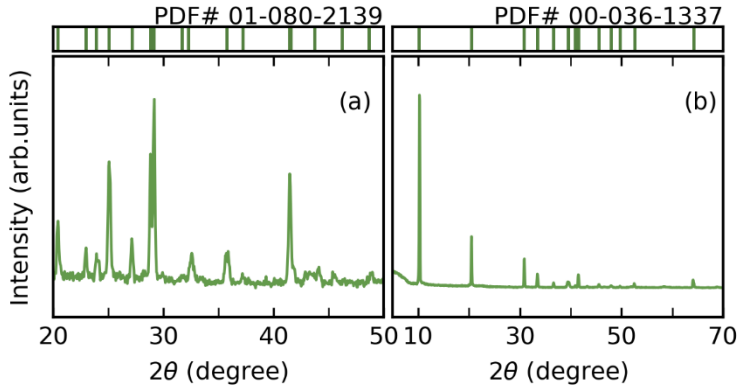

Fig.S1. PXRD patterns for (a) $CsSnI_3$ and (b) TiS_3 after synthesis.

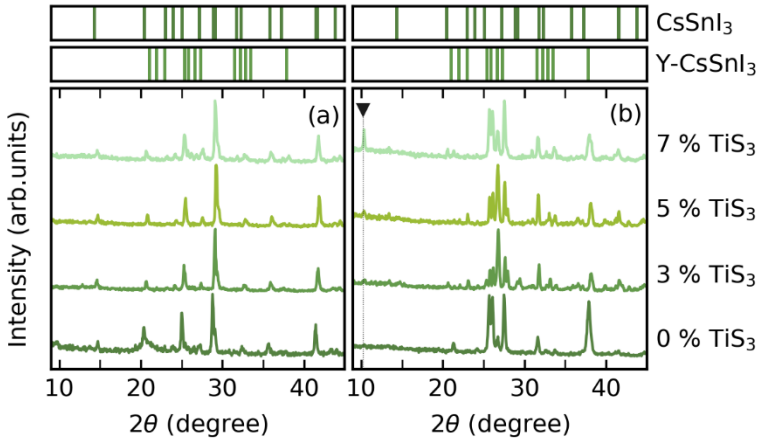

Fig.S2. XRD patterns (a) of the surfaces of bulk samples and (b) of the milled samples after pressure-less sinter.

Raman data

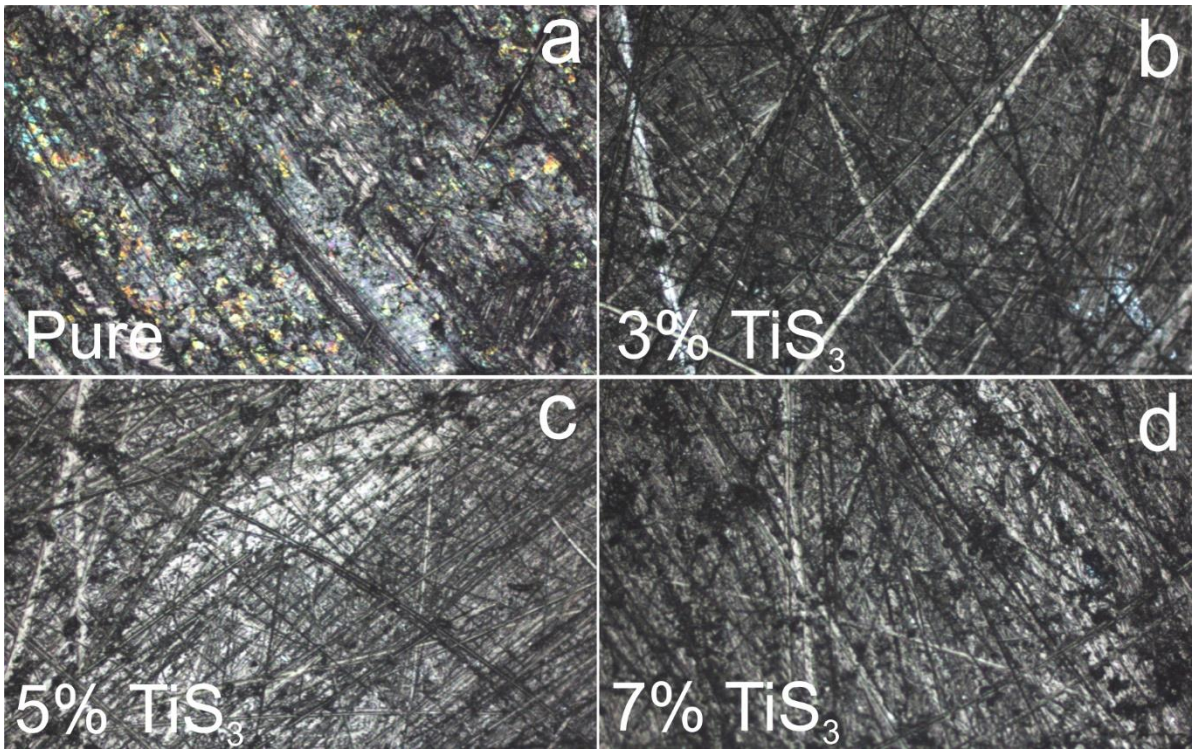

Fig.S3. Microphotography with magnification x20 of $CsSnI_3$ tablets surfaces after 24h air exposure.

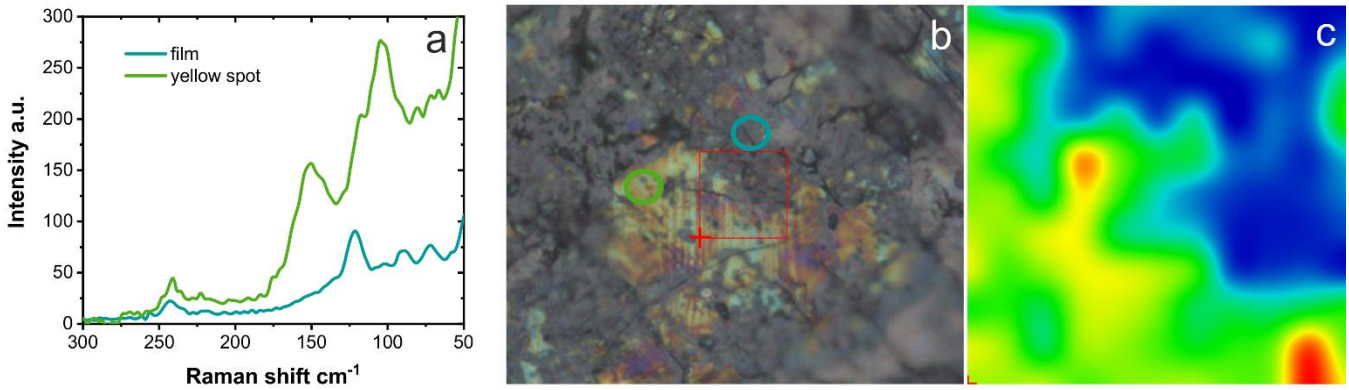

Fig.S4. Raman spectra (a) and raman map (b,c) of yellow-black region on surface of pure $CsSnI_3$ tablet after 24 air exposure.

SEM images and EDX mapping

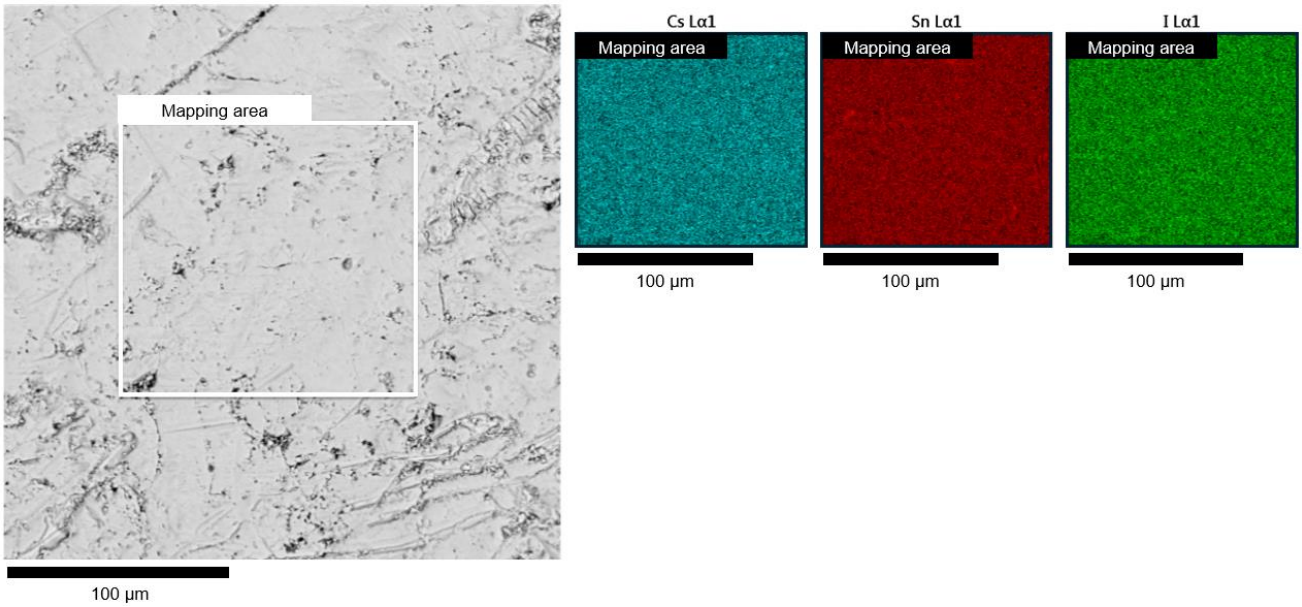

Fig. S5. SEM image of the polished surface of the $CsSnI_3$ without air exposure specimen and corresponding EDX maps.

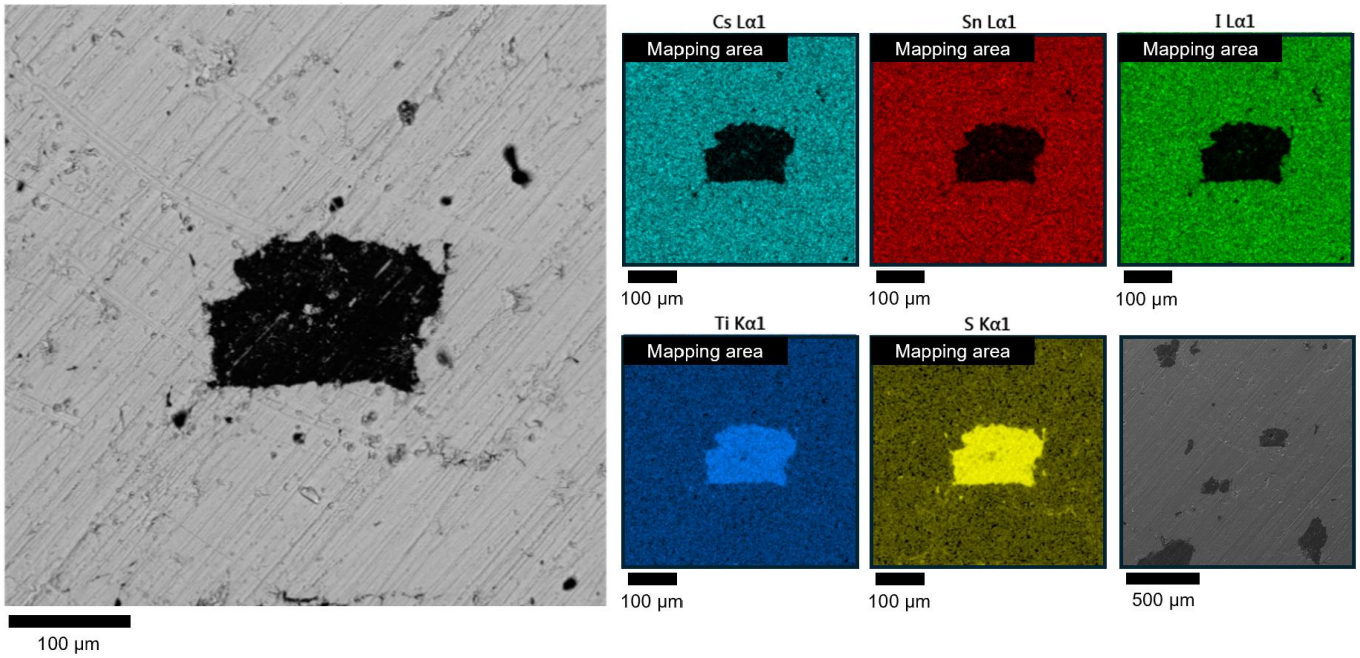

Fig. S6. SEM image of the polished surface of the $CsSnI_3$ + 3 wt. % TiS_3 without air exposure specimen and corresponding EDX maps.

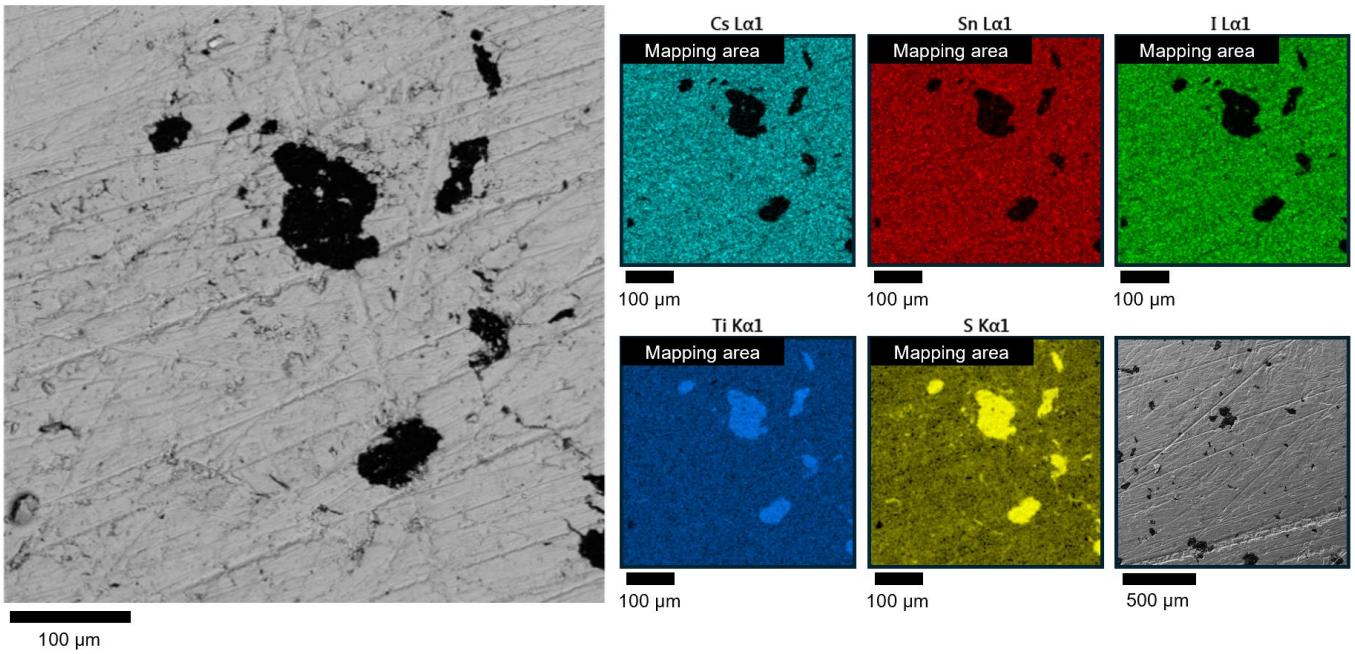

Fig. S7. SEM image of the polished surface of the $CsSnI_3$ + 5 wt. % TiS_3 without air exposure specimen and corresponding EDX maps.

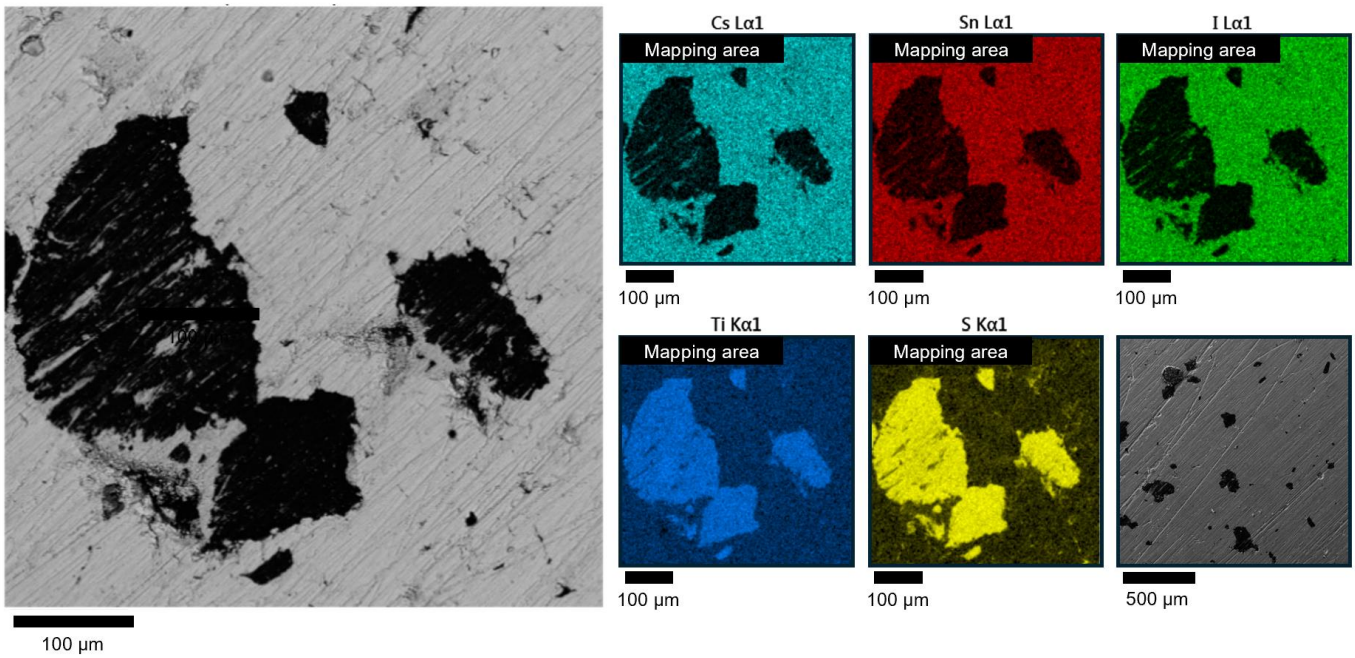

Fig. S8. SEM image of the polished surface of the $CsSnI_3$ + 7 wt. % TiS_3 without air exposure specimen and corresponding EDX maps.

XRD data and EDX data

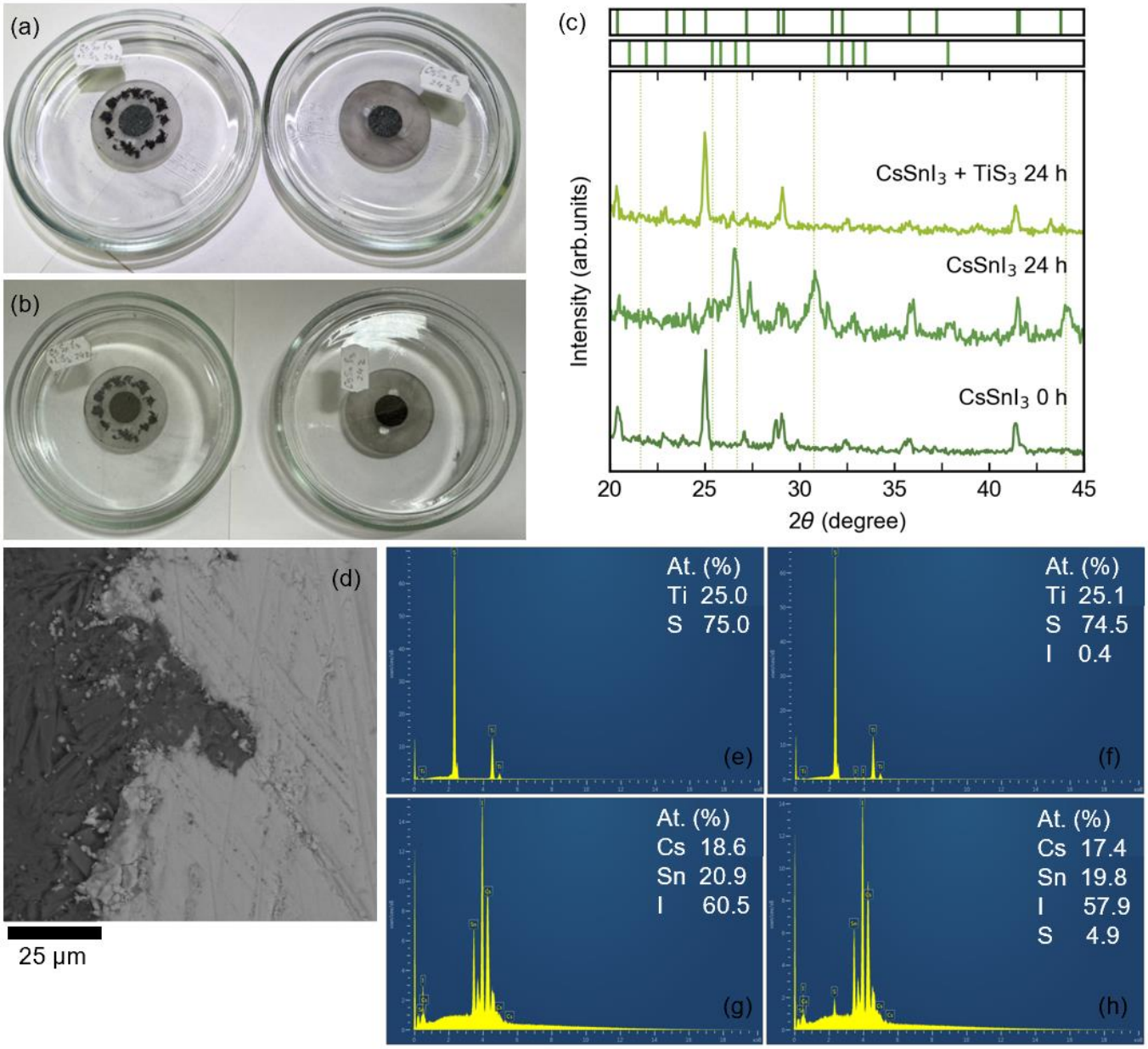

Fig. S9. Photos of prepared powders (a) after 5 hours in the box and (b) 24 hours in the air, (c) XRD of these powders, (d) SEM image of the sample $CsSnI_3$ + 15 wt.% TiS_3, EDX spectrum analysis (e) of pure TiS_3, (f) near the grain boundaries on TiS_3 side, (g) of pure $CsSnI_3$, (h) near the grain boundaries on CsSnI3 side (atomic %).

Electrical transport properties

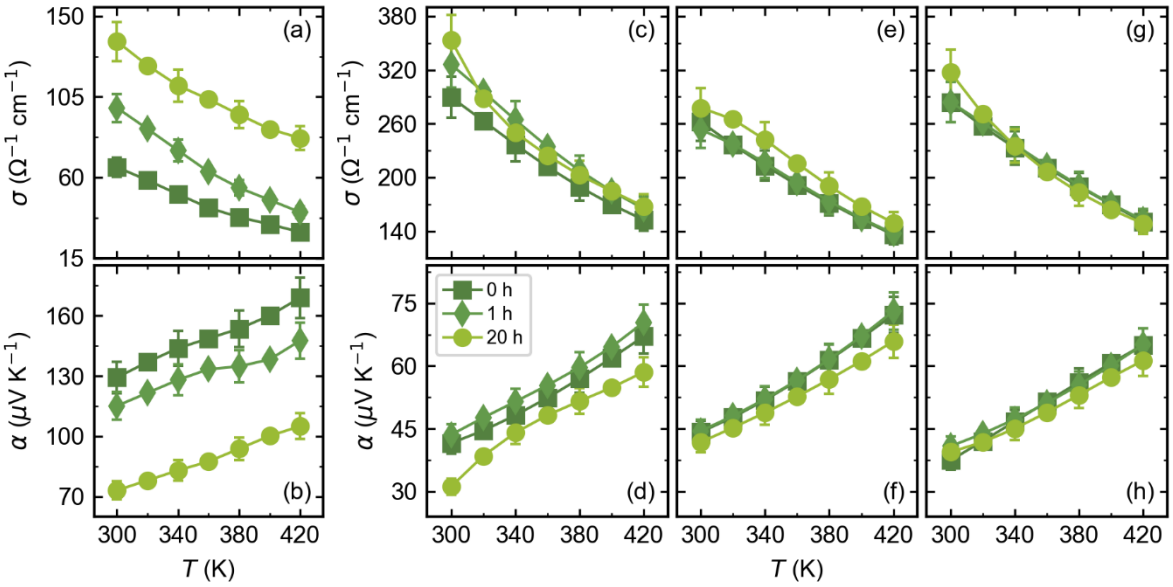

Fig. S10. Temperature dependence of electrical conductivity σ and Seebeck coefficient α of (a, b) $CsSnI_3$, (c, d) $CsSnI_3$ + 3 wt.% TiS_3, (e, f) $CsSnI_3$ + 5 wt.% TiS_3, (g, h) $CsSnI_3$ + 7 wt.% TiS_3.

Thermal transport properties

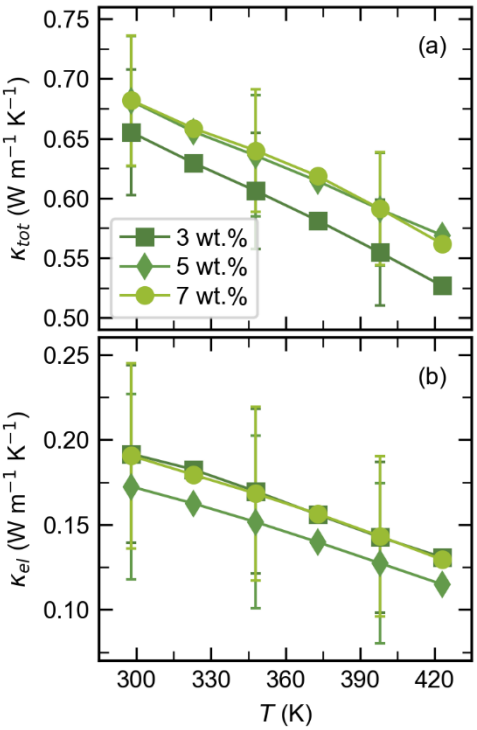

Fig. S11. Temperature dependence of (a) the total thermal conductivity and (b) the electrical thermal conductivity of the $CsSnI_3$ + *x* wt.% TiS_3 (*x* = 3, 5 and 7 wt.%)