Anomalous Hall Effect in (111)-oriented $Sn_{1-x}Mn_xTe$ Epilayers

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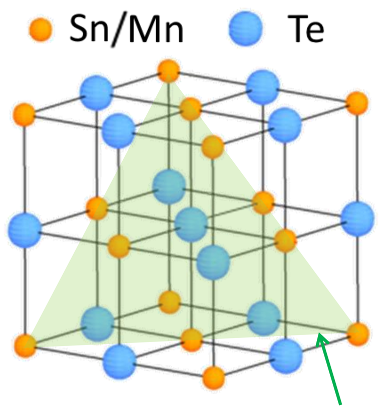
Introduction / Motivation

Topological crystalline insulators:

- Topological surface states (TSS) are protected by the (110) mirror plane symmetry
- SnTe is an archetypical topological crystalline insulator

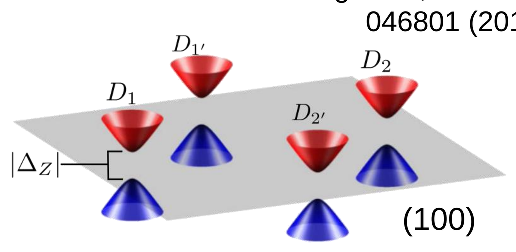


Material: Ternary $Sn_{1-x}Mn_xTe$:

- Transition metal Mn-doped SnTe is a ferromagnet
- RKKY exchange interaction

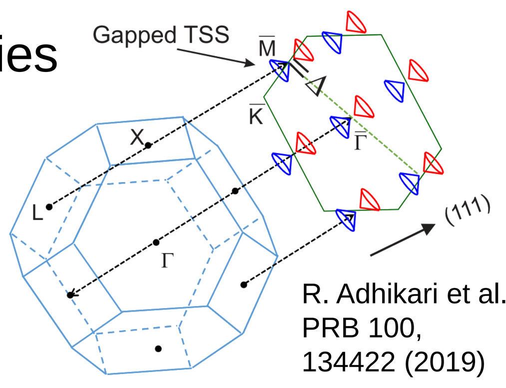
Motivation

- Magnetically-doped TCI are host to the large-Chern-number quantum anomalous Hall effect



Goal of present work

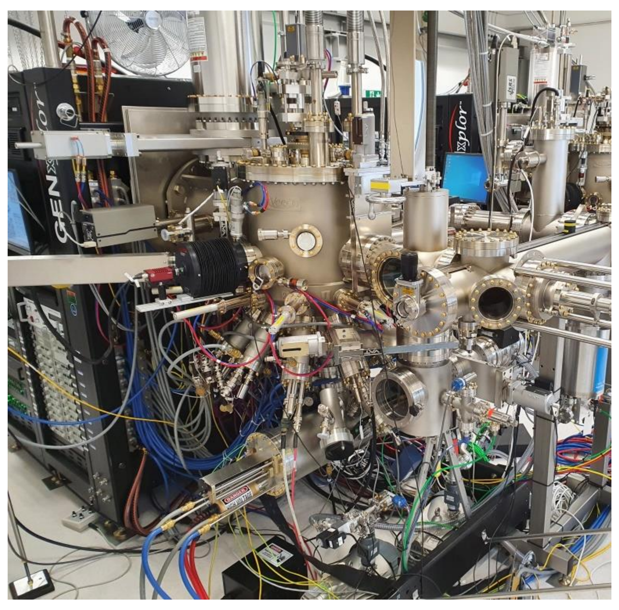
- Study of the magnetotransport properties of thin epilayers of $Sn_{1-x}Mn_xTe$ to understand the evolution of anomalous Hall effect and magnetoresisance with Mn doping

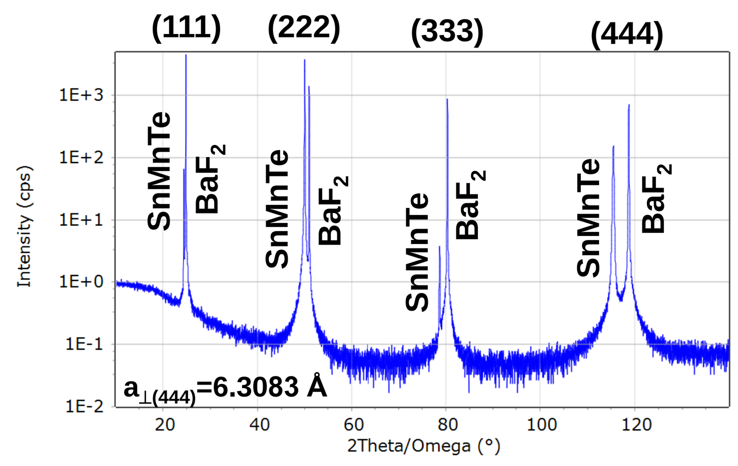


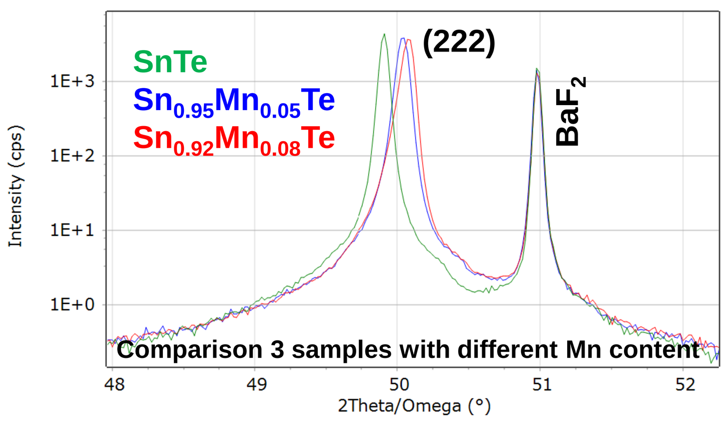
Growth and samples details

MBE growth

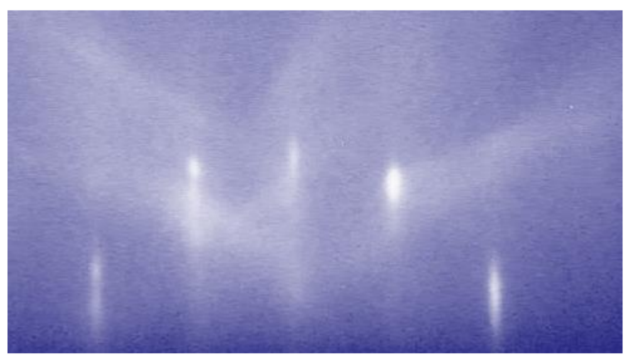
- Veeco GENxplor, SnTe, Mn, Te sources, (111)-BaF_2 substrates, T_S=350 °C, P_0 = 10^{-10} mBar
- $Sn_{1-x}Mn_xTe$ films, x_{Mn}= 0 ÷ 0.1, 1 μm nominal thickness
- RHEED *in-situ*, shows streaky pattern, smooth surface, 2D growth mode
- AFM confirms excellent surface quality, monolayer thick steps are resolved; same RMS for Mn doped and undoped samples proves no inclusions of Mn reach phase up to x_{Mn}= 8 %
- XRD maxima from single crystalline (111) oriented film, systematic reduction of lattice constant with Mn doping, no inclusions of other phases up to x_{Mn}= 8 %, small compressive strains of -0.1 % detected from asymmetric RSM



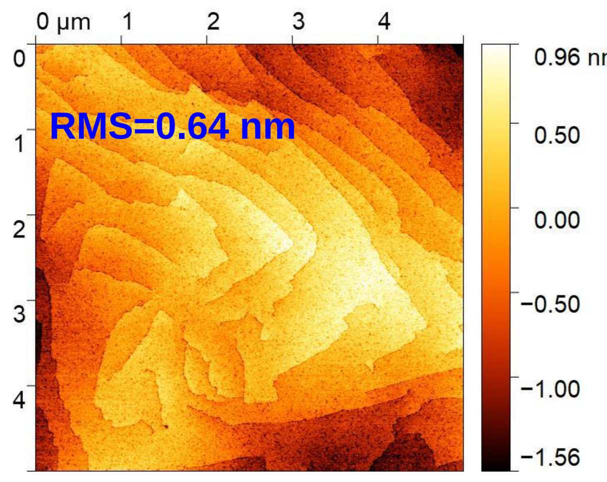




RHEED, along [110]



AFM

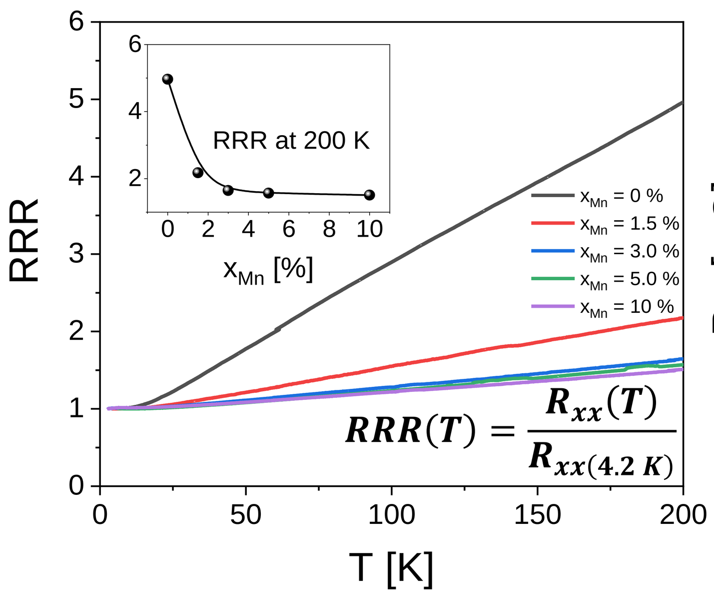


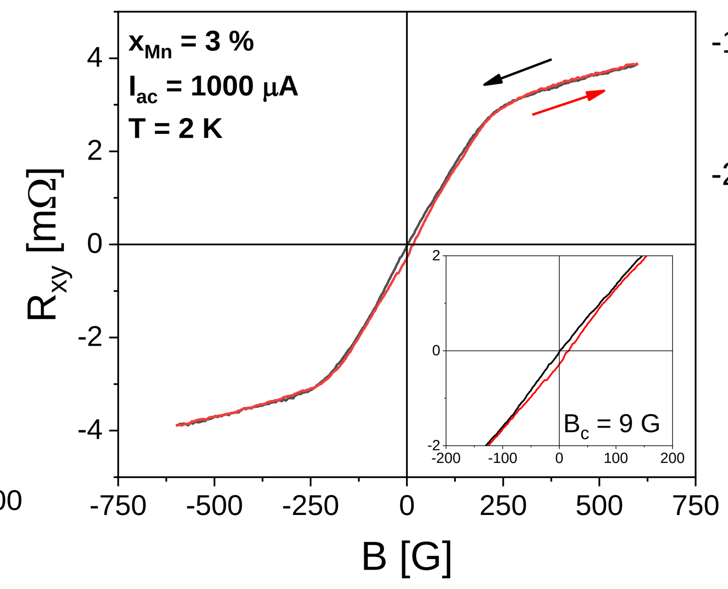
Electrical Transport

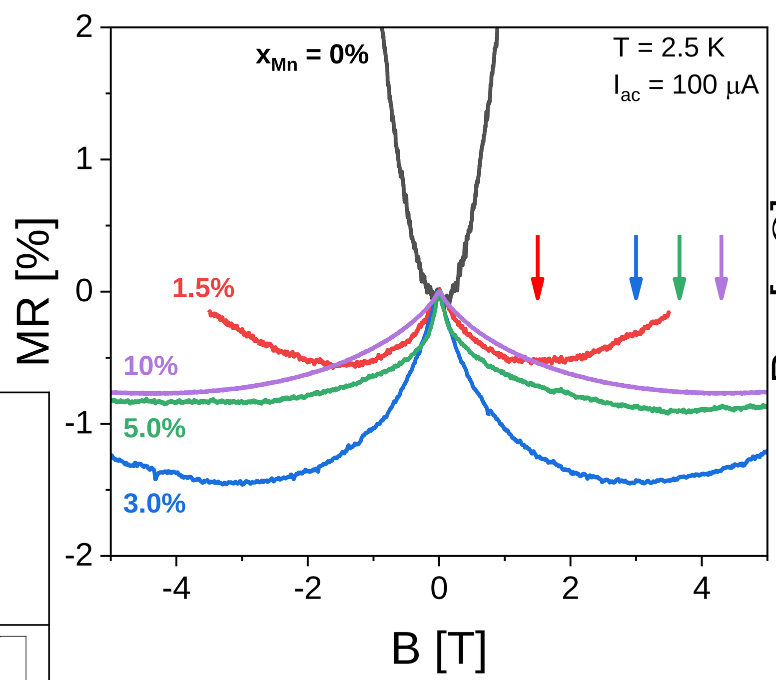
Sample	x_{Mn} [%]	T_c [K]	R_{xx} at 4.2 K [Ω·cm]	p [10^{20} cm^{-3}]	μ [cm²/Vs]
S#1	0	---	1.83·10⁻⁵	3.12	1065
S#2	1.5	2.2	4.57·10⁻⁵	7.78	184
S#3	3.0	6.0	29.95·10⁻⁵	3.86	72
S#4	5.0	6.4	33.42·10⁻⁵	11.21	41
S#5	10	8.2	186.3·10⁻⁵	6.79	49

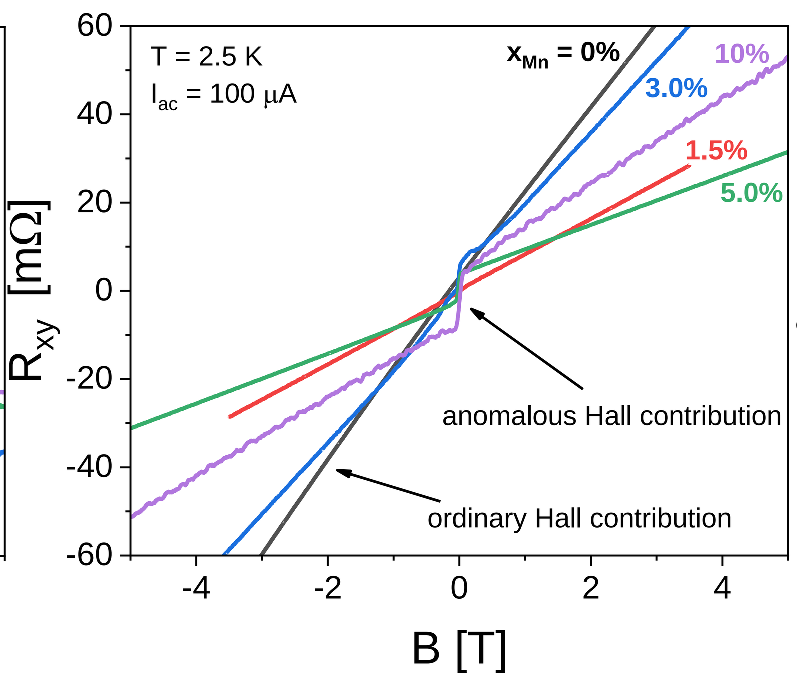
x_{Mn} = 10 %

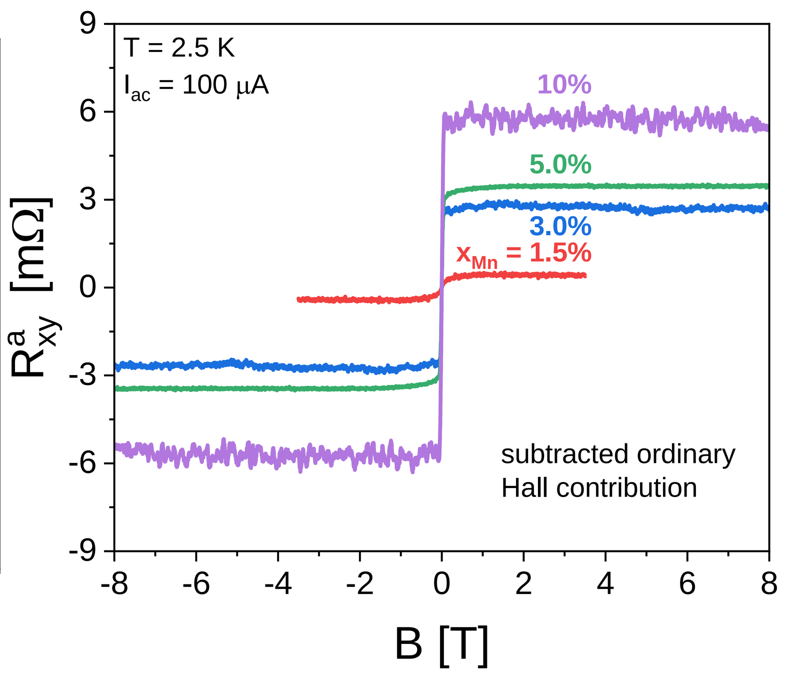
Silver paste was used for contacts



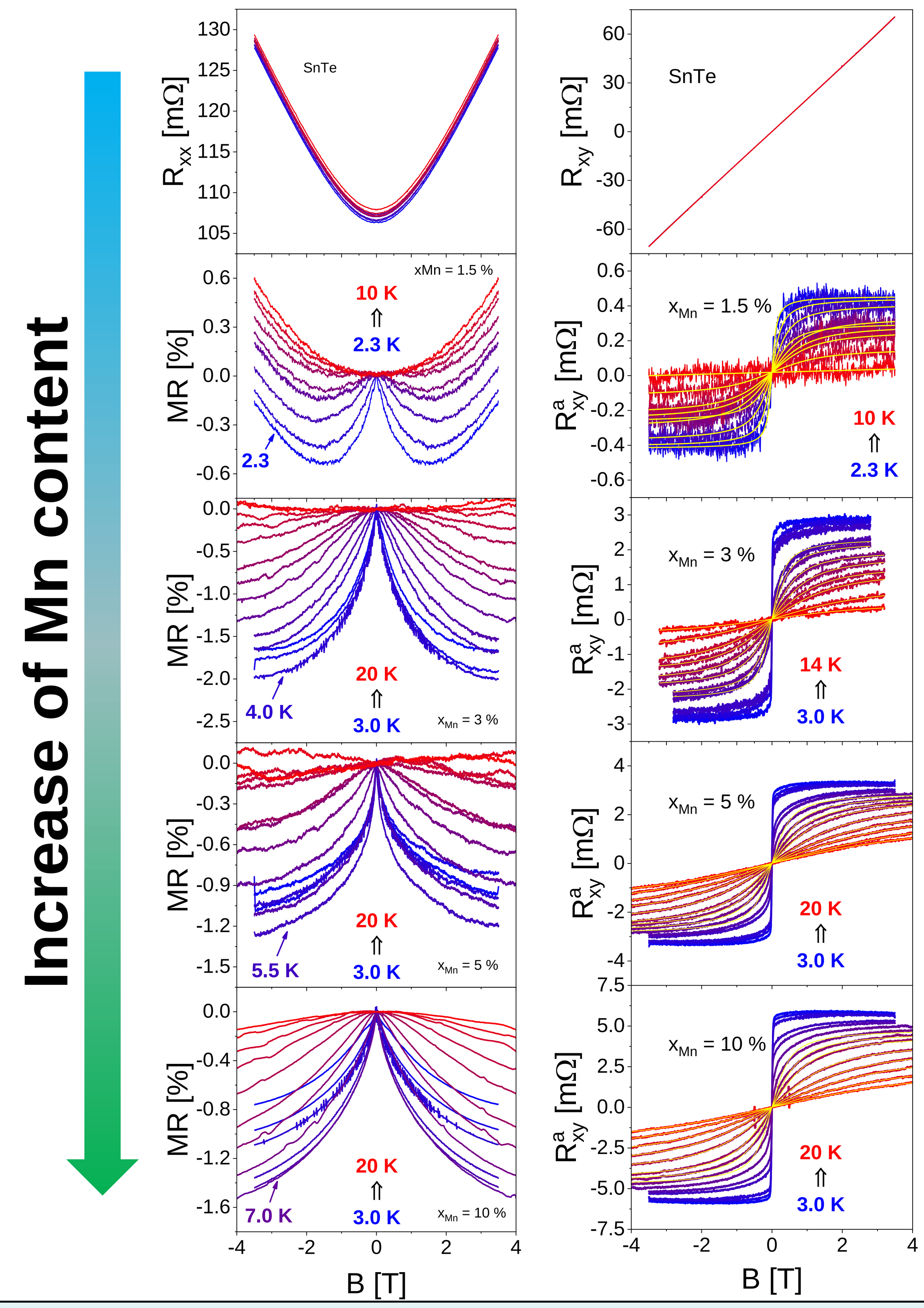


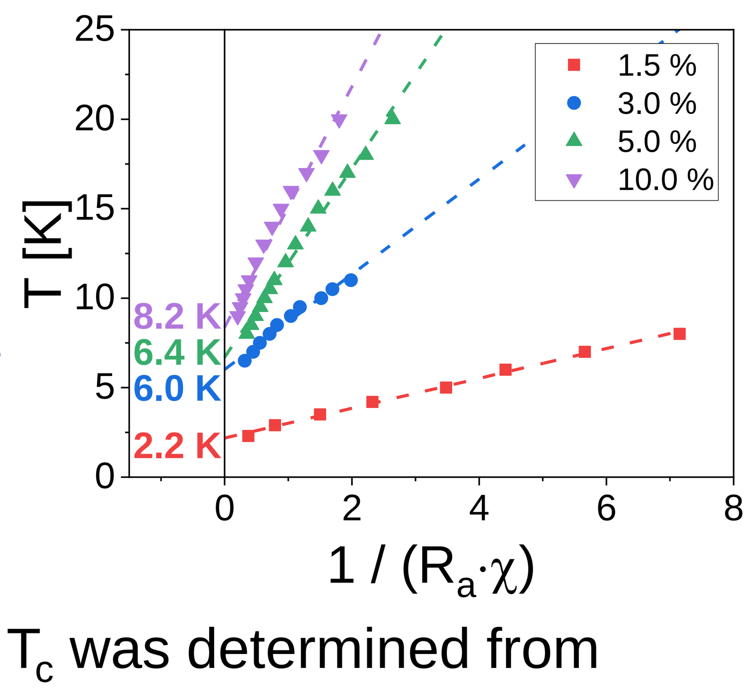




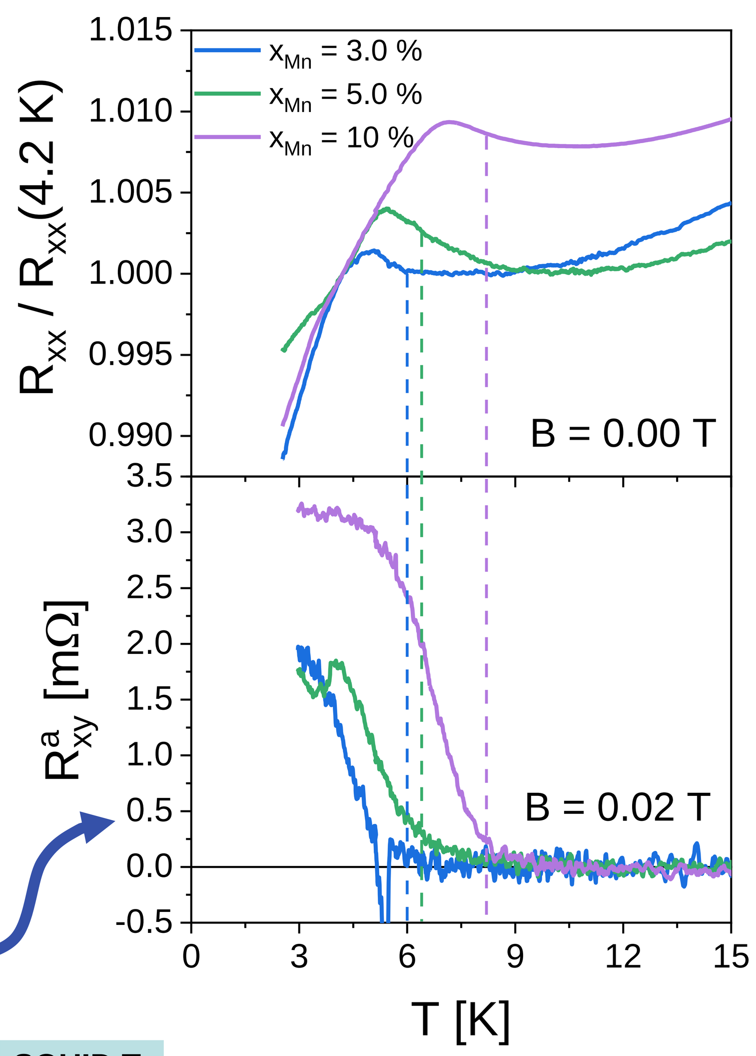


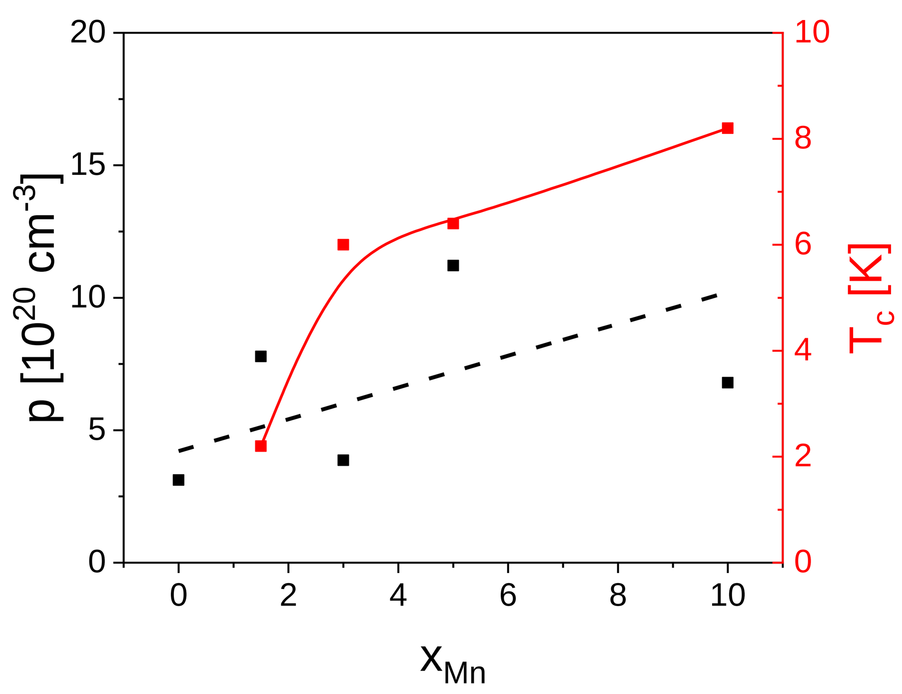
- Metallic $R_{xx}(T)$ weakens with Mn-doping, which points to increase in scattering
- MBE-grown Mn-doped samples have higher ***p*** and lower ***μ***, than undoped sample
- AHE and negative MR are observed in Mn-doped samples with very low coercivity
- High field linear slope was subtracted from Hall curve to obtain AHE contribution
- Onset of high-field positive MR and value of AHE scales with Mn content





T_c was determined from inverse susceptibility of AHE curves, these values agrees with the critical behavior observed on temperature dependence of R_{xx} and R_{xy}





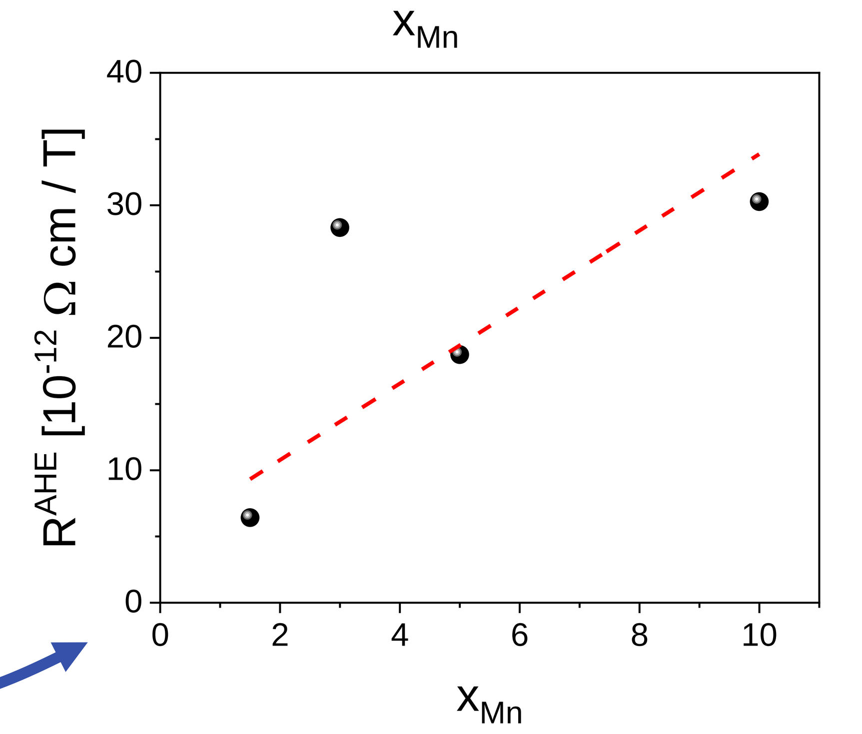
Good agreement between SQUID and magnetotransport data

x_{Mn} [%]	AHE T_c [K]	SQUID T_c [K]
1.5	2.2	2
3.0	6.0	5.1
5.0	6.4	5.4
10	8.2	7.5

AHE coefficients:

$$R_{xy} = R_0 B + R^{AHE} M$$

$$R^{AHE} = R^{AHE}_{xy} / M$$



Main results

- Systematic study of magnetotransport properties in MBE-grown (111)-oriented $Sn_{1-x}Mn_xTe$ epilayers was performed
- Mangetotransport data agrees well with magnetization measurements
- AHE coefficients are extracted

Acknowledgements

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