Science Advances

AAAS

advances.sciencemag.org/cgi/content/full/3/12/eaao4949/DC1

Supplementary Materials for

Elastic and electronic tuning of magnetoresistance in $MoTe_2$

Junjie Yang, Jonathan Colen, Jun Liu, Manh Cuong Nguyen, Gia-wei Chern, Despina Louca

Published 15 December 2017, *Sci. Adv.* **3**, eaao4949 (2017)
DOI: 10.1126/sciadv.aao4949

This PDF file includes:

Supporting Online Material

XRD for $MoTe_2$ single crystals.

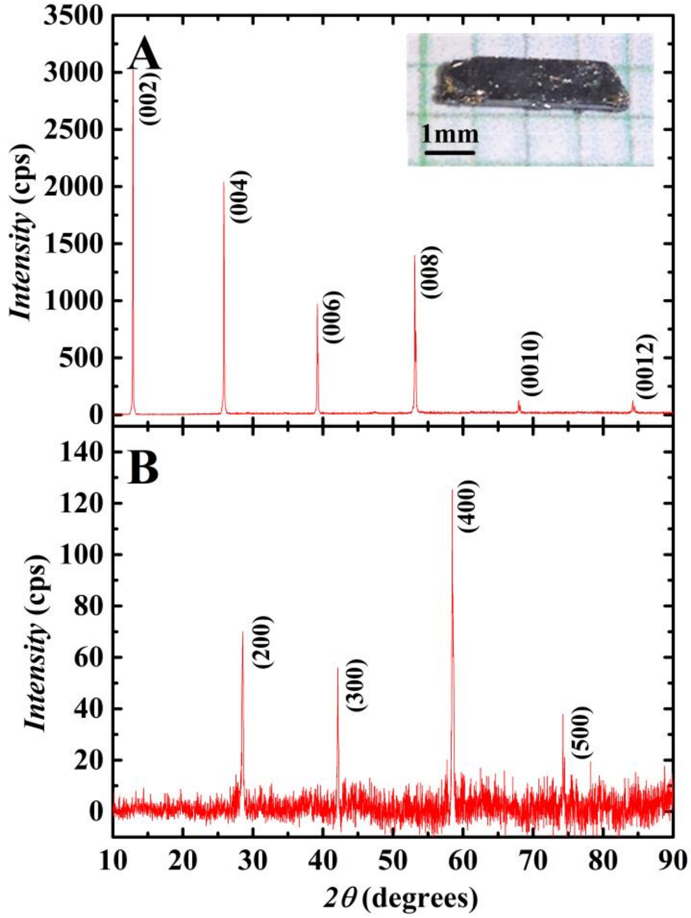

fig. S1. XRD for $MoTe_2$ single crystal. XRD of $MoTe_2$ single crystals aligned along: (a) (00L) and (b) (H00). The inset in A is a picture of a $MoTe_2$ single crystal.

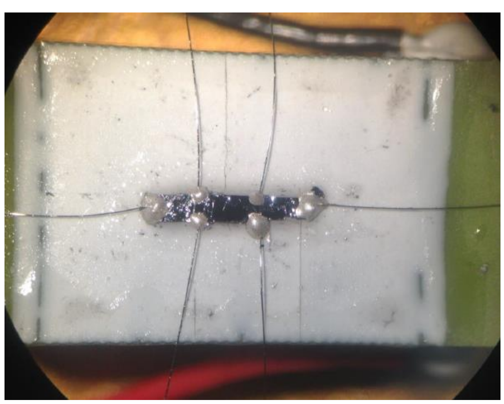

fig. S2. $MoTe_2$ crystal on the piezoelectric stack.

***SMR* of different samples.**

Figure S3 shows the electrical transport data under different strain for two different samples. All results were measured at 2 K, and the strain was applied along the *b* direction. *SMR* is defined as $SMR = \frac{[R(\varepsilon,H)-R(\varepsilon,0)]-[R(0,H)-R(0,0)]}{R(0,0)} \times 100\%$. Figs. S3 A and B are plots of the resistance vs magnetic field. Figs. S3 C and D show the calculated SMR as a function of magnetic field for the two samples. As it can be seen from figs. S3 C and D, the strain effect mainly appears at high magnetic fields and varies with sample. Sample 2 exhibits a much bigger strain effect than sample 1. Fig. S4 are plots of the electrical transport data under different strain, with strain applied along *a* for two different samples. The strain effect mainly appears at high magnetic fields and varies with sample. Sample 4 exhibits a much bigger strain effect than sample 3.

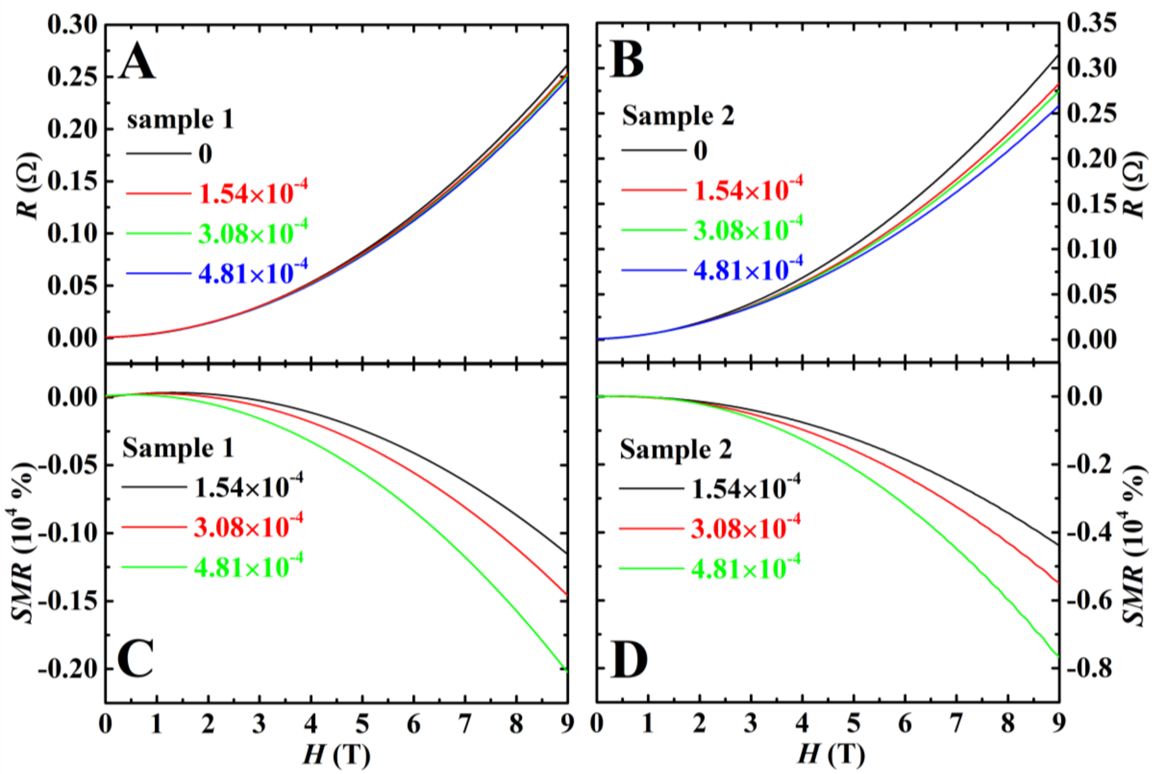

fig. S3. Transport and SMR data on samples 1 and 2. Electrical transport data measured at 2 K for two different samples: (A), *R*-*H* curves under different strain for sample 1, (B) *R*-*H* curves under different strain for sample 2, (C) *SMR* as a function of magnetic field for sample 1 and (D) *SMR* as a function of magnetic field for sample 2. Strain was applied along *b* direction.

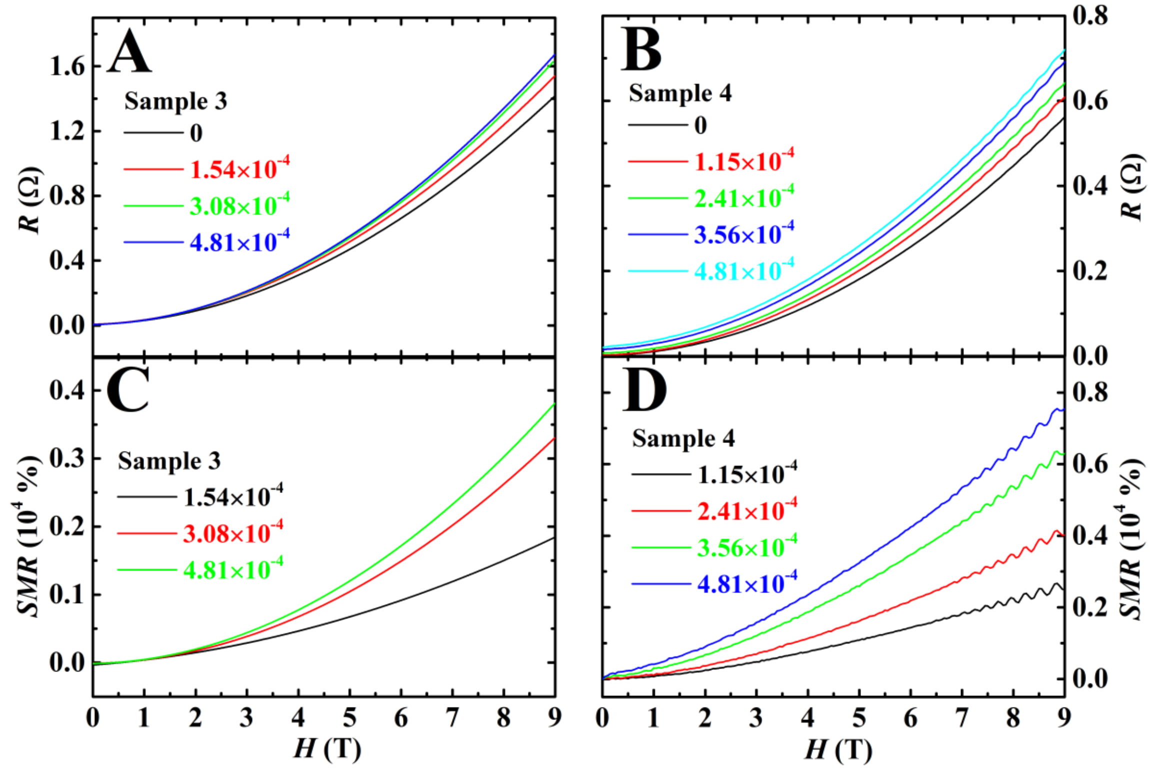

fig. S4. Transport and SMR data on samples 3 and 4. Electrical transport data measured at 2 K for two different samples: (A), *R-H* curves under different strain for sample 3, (B) *R-H* curves under different strain for sample 4, (C) *SMR* as a function of magnetic field for sample 3 and (D) *SMR* as a function of magnetic field for sample 4. Strain was applied along *a* direction.

Hall Effect and Two-band model fitting

Figure S5 shows the results of the Hall effect and the two-band model fitting. The electrical transport data was measured at 2 K with strain applied along the *b* direction. Figs. S5 A and B show the Hall conductivity $\sigma_{xy} = -\rho_{xy}/(\rho^2_{xy} + \rho^2_{xx})$ and the longitudinal conductivity $\sigma_{xx} = \rho_{xx}/(\rho^2_{xy} + \rho^2_{xx})$ measured without strain. According to the two-band model (29, 39-41), the Hall conductivity is $\sigma_{xy} = \left[\frac{n_e\mu_e^2}{1+(\mu_e\mu_0H)^2} - \frac{n_h\mu_h^2}{1+(\mu_h\mu_0H)^2}\right] e\mu_0H$, and the longitudinal conductivity is $\sigma_{xx} = \frac{n_ee\mu_e}{1+(\mu_e\mu_0H)^2} + \frac{n_he\mu_h}{1+(\mu_h\mu_0H)^2}$. The red lines shown in figs. S5 A and B are the fitting curves. Figs. S5 C-F show the extracted carrier density, n, and mobility, μ_e for electrons and μ_h for holes. Both carrier density and mobility decrease with increasing strain when strain is applied along the *b* direction.

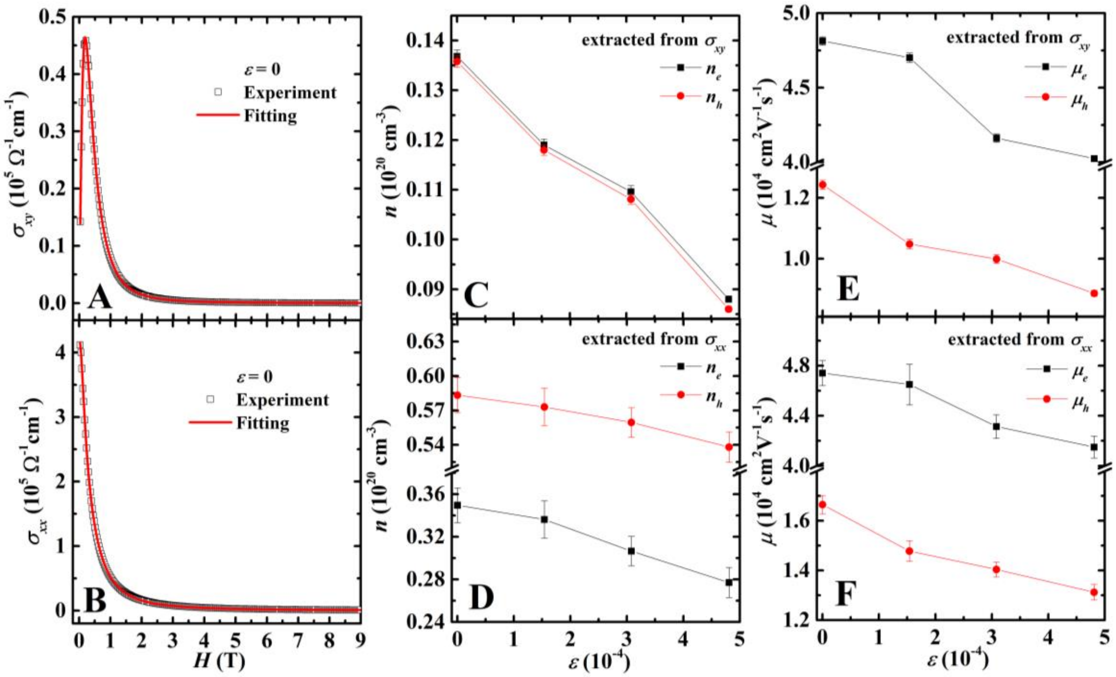

fig. S5. Conductivity, carrier density, and mobility with and without strain. (A) Hall conductivity σ_{xy} and (B) the longitudinal conductivity σ_{xx} measured without strain at 2 K. (C) Electron and hole densities extracted from the fitting of σ_{xy}, (D) electron and hole densities extracted from the fitting of σ_{xx}, (E) electron and hole mobilities extracted from the fitting of σ_{xy} and (F) electron and hole mobilities extracted from the fitting of σ_{xx}. Strain was applied along *b* direction.

Strain vs Voltage

table S1. The piezoelectric stack shows an almost linear behavior in the voltage range of 0 to 150 V. Hence, we used the maximum response of the piezoelectric stack at 150 V to estimate the strain values for different voltages: $\varepsilon = \varepsilon_{max} \times V/150$. $\varepsilon_{max} = 14.44 \times 10^{-4}$.

Voltage (V)	12	16	25	32	37	50
Strain (10^{-4})	1.15	1.54	2.41	3.08	3.56	4.81