Supplementary Information (SI) for Journal of Materials Chemistry C.

Supporting information

Effects of Thermal Rectification Phenomenon Induced by Structural Regulation on the Thermoelectric Performance of Two-dimensional Bi_2Se_3 Films

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1. Fabrication of suspended microelectrodes

Fabrication process of suspended microelectrodes are shown in Figure S1.

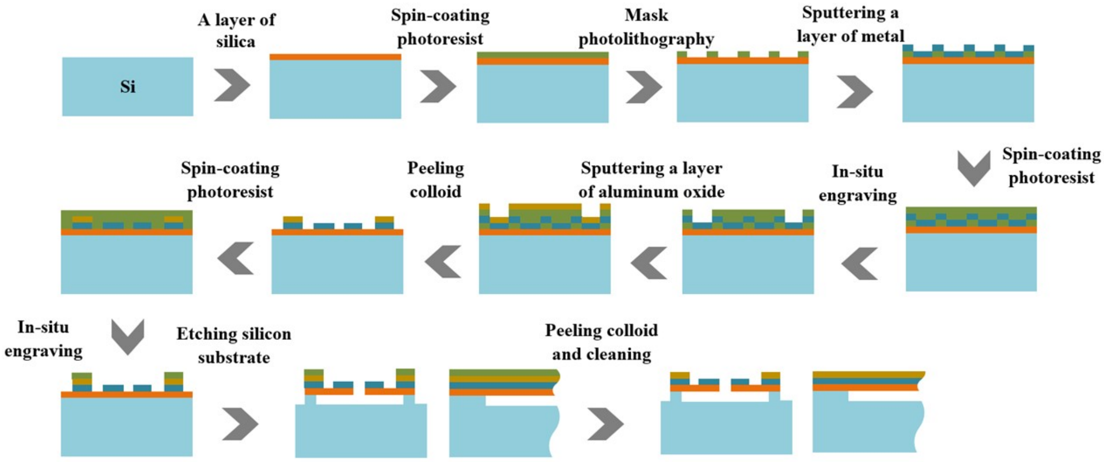

Figure S1. Fabrication process of suspended microelectrodes.

2.Sample transfer

Figure S2 shows the transfer process. The reason for choosing this method is that using PMMA transfer Bi_2Se_3 films is more reliable than PDMS method. PDMS transfer of 2D films has the possibility to make parts of the film damage.

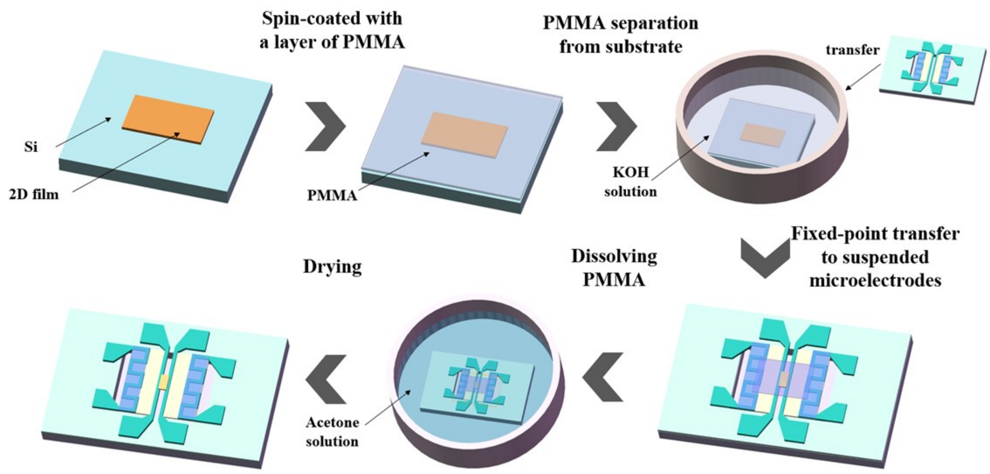

Figure S2. Transfer process with PMMA method.

3.Uncertainty analysis

The *ZT* calculation used in the experiment is shown in formula (1)， where I_3, V_3, and V_4 are the current, DC voltage, and Seebeck voltage between microelectrodes 6 and 7,

L_9 is the length of the sample, A is the cross-sectional area of the sample, R_5, R_6, R_7, R_8, and $R_5^{'}$, $R_6^{'}$, $R_7^{'}$, $R_8^{'}$ are the original resistance and heated resistance of microelectrodes 5, 6, 7, and 8, Q represents the heat flow through the sample, α is the temperature coefficient of resistance of the microelectrode, U is the heating voltage across microelectrode 5. The error formula can be used to calculate the error of ZT as follows [1].

$$ZT = \frac{S^2\sigma}{\lambda}T = \frac{\left(\frac{V_4}{\frac{\left(\frac{R_6^{'}}{R_6}-1\right)}{\alpha}-\frac{\left(\frac{R_7^{'}}{R_7}-1\right)}{\alpha}}\right)^2\frac{I_3L_9}{V_3A}}{\frac{QL_9}{A}\left(\frac{\left(\frac{R_5^{'}}{R_5}-1\right)}{\alpha}-\frac{\left(\frac{R_8^{'}}{R_8}-1\right)}{\alpha}\right)^{-1}}T = \frac{V_4{}^2\alpha I_3T}{QV_3}\frac{1}{\left(\frac{R_5^{'}}{R_5}-\frac{R_8^{'}}{R_8}\right)} \tag{1}$$

$$\left(\frac{\delta ZT}{ZT}\right)^2 = 3\left(\frac{\delta V}{V}\right)^2 + \left(\frac{\delta I}{I}\right)^2 + \left(\frac{\delta Q}{Q}\right)^2 + \left(\frac{\delta T}{T}\right)^2 + 2\left(\frac{\delta R^{'}}{R^{'}}\right)^2 + 4\left(\frac{\delta R}{R}\right)^2 \tag{2}$$

$$\left(\frac{\delta Q}{Q}\right)^2 = 2\left(\frac{\delta U}{U}\right)^2 + 4\left(\frac{\delta R^{'}}{R^{'}}\right)^2 + 6\left(\frac{\delta R}{R}\right)^2 \tag{3}$$

The electrode voltage is provided by a lock-in amplifier (7265DSP), with a minimum heating voltage of 0.104V and an uncertainty of 0.001V. So the uncertainty of U is $\delta U/U \sim 0.96\%$. The resistance was controlled by a resistor box, which was 0.1 ohms of adjustable minimum, and the minimum initial and measuring resistance were 14.0 and 14.9 ohms, so the uncertainty of R and R' was $\delta R / R$ and $\delta R' / R' \sim 0.71\%$ and 0.69%. The I was controlled by digital source meter with an uncertainty of 0.03%. The Seebeck voltage V was measuring by an Agilent nanovoltmeter with an uncertainty of 0.0002 mV. The minimum voltage is 0.0323mV, so the uncertainty of V was $\delta V / V \sim$ 0.62%. The maximum uncertainty of ambient temperature $\Delta T_3 / T_3$ is ±0.1 °C for 20.0 °C ~ 1%. By substituting all these uncertainties into equations (1), $\delta ZT / ZT$ was calculated as ~ 3.45%.

References

[1] Taylor, J. R.; Thompson, W. An Introduction to Error Analysis: The Study of Uncertainties in

Physical Measurements. *Physics Today* **1998,** *51* (1), 57-58.