Supporting Information

Narrow-gap physical vapour deposition synthesis of ultrathin SnS$_{1-x}$Se$_x$ ($0 \leq x \leq 1$)

Two-dimensional Alloys with unique polarized Raman spectra and high
(opto)electronic properties.

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Fig. S1 Optical images of the SnS$_{1-x}$Se$_x$ alloyed nanosheets by different wafer methods: (a) one wafer method. (b) two wafers covered each other.
**Fig. S2** (a) Schematic diagram for the traditional growth of 2D SnS$_{1-x}$Se$_x$ alloyed nanosheets. The samples were grown on the top of the SiO$_2$/Si substrate. (b) Enlarged image of the black ellipse, showing the detailed orientation growth of the alloyed sample.

**Fig. S3** SEM-EDS of the SnS$_{0.5}$Se$_{0.5}$ alloyed nanosheets
Table S1. The calculation result extracted from the corresponding EDS spectrum in Fig. S4 SEM-EDS of the SnS$_{0.75}$Se$_{0.25}$ alloyed nanosheets

<table>
<thead>
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<th>Element</th>
<th>Atomic (%)</th>
<th>Theoretical Atomic (%)</th>
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<tbody>
<tr>
<td>S</td>
<td>22.02</td>
<td>20</td>
</tr>
<tr>
<td>Se</td>
<td>20.15</td>
<td>20</td>
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<tr>
<td>S/Se ratio</td>
<td>1.09</td>
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Fig. S4 SEM-EDS of the SnS$_{0.75}$Se$_{0.25}$ alloyed nanosheets

Table S2. The calculation result extracted from the corresponding EDS spectrum in Figure S3.

<table>
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<tbody>
<tr>
<td>S</td>
<td>32.79</td>
<td>30</td>
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<tr>
<td>Se</td>
<td>10.08</td>
<td>10</td>
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<tr>
<td>S/Se ratio</td>
<td>3.25</td>
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Table S3. The calculation result extracted from the corresponding EDS spectrum in Figure S4.

<table>
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<tr>
<th>Element</th>
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<tbody>
<tr>
<td>S</td>
<td>12.23</td>
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<tr>
<td>Se</td>
<td>28.94</td>
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<tr>
<td>S/Se ratio</td>
<td>0.42</td>
<td>0.33</td>
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**Fig. S6** SEM images of the SnS$_{1-x}$Se$_x$ alloyed nanosheets via two wafers method (a) Trapezoid. (b) Square. (c) Rectangle.

**Fig. S7** (a) Transfer characteristic curve of the device under drain voltage of 1 V under dark condition. Inset: the optical image of the device, scale bar: 10 μm. (b) Output characteristic curves of the device under different $V_g$ values (from 80 V to -80 V using step of 40 V).
**Fig. S8** Macroscopic scheme of NGPVD method, showing the detailed orientation growth of the alloyed sample.

**Fig. S9** Microcosmic scheme of NGPVD method, showing the detailed orientation growth of the alloyed sample.

**Fig. S10** Normalized Raman spectra of the SnS$_{0.5}$Se$_{0.5}$ nanosheets with different
Fig. S11 The microcosmic scheme of FETs devices based on SnS$_{1-x}$Se$_x$ alloyed samples. (a) and (b) for ultrathin sample. (c) and (d) for thicker sample (larger than 25 nm).