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## **Supporting Information:**

## Effects of annealing temperature and ambient

## on metal-PtSe<sub>2</sub> contact alloy formation

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**Figure S1**: Representative cross-section TEM images of the PtSe<sub>2</sub> contacted with Ti/Au (a) before and (b) after annealing at 250 °C in FG, showing that the layered structure of the PtSe<sub>2</sub> is maintained after annealing.



**Figure S2:** Raman signal collected from the PtSe<sub>2</sub> region (not the alloy region) after each annealing variation. (a) and (c) show the Raman signal after annealing in forming gas for each temperature for the Ti/Au and Ni/Au samples respectively. (b) and (d) show the Raman signal after annealing at 250 °C and 350 °C in FG and inert environment for the Ti/Au and Ni/Au samples respectively. When the annealing condition is too harsh the PtSe<sub>2</sub> signal is lost.



**Figure S3:** Additional XPS spectra of as-deposited Ni/PtSe<sub>2</sub> samples. a) Ni  $2p_{3/2}$ , (b) O 1*s*, (c) C 1*s*, and (d) Si 2p spectra.

Figure S2 shows spectra of the as-deposited Ni on PtSe<sub>2</sub> in addition to those included in the main article. The Ni  $2p_{3/2}$  spectra show a metallic Ni signal at 851.2 eV, and a broad peak centered at ~853 eV. This higher BE peak cannot be directly attributed to the formation of a NiSe<sub>x</sub> due to the number of complex satellite peaks present at higher BE in a Ni 2p spectra, along with the multiple peak splitting which can occur for Ni compounds. The O 1*s* spectra shows an increase in oxidation (compared to bare PtSe<sub>2</sub>) following Ni deposition. This is primarily due to oxidation of the Nickel surface. No significant change in the C 1*s* or Si 2psignal is observed between bare PtSe<sub>2</sub> and Ni on PtSe<sub>2</sub>, indicating no C contamination, or thinning of the PtSe<sub>2</sub> layer (which would lead to an increased Si signal).



**Figure S4:** Additional XPS spectra of as-deposited Ti/PtSe<sub>2</sub> samples. a) Ti 2*p*, (b) O 1*s*, (c) C 1*s*, and (d) Si 2*p* spectra.

Figure S3 shows additional spectra of the as-desposited Ti on PtSe<sub>2</sub>. The Ti 2p spectra show a no evidence of a metallic Ti signal rather the peak shape and position are that expected for TiO<sub>2</sub>. This is expected given the very low formation energy of TiO<sub>2</sub>, and the oxygen-gettering nature of Ti. This complete oxidation of the Ti (BE = 529.5 eV) can also be clearly seen in the drastic increase in the O 1*s* signal. No significant change in the C 1*s* or Si 2p signal is observed between bare PtSe<sub>2</sub> and Ti on PtSe<sub>2</sub>, again indicating no C contamination, or thinning of the PtSe<sub>2</sub> layer.