Supporting Information:

Effects of annealing temperature and ambient on metal-$PtSe_2$ contact alloy formation

Gioele Mirabelli[1], Lee A. Walsh[1], Farzan Gity[1], Shubhadeep Bhattacharjee[1], Conor P. Cullen[3], Cormac Ó Coileáin[3], Scott Monaghan[1], Niall McEvoy[3], Roger Nagle[1], Paul K. Hurley[1,2], Ray Duffy[1]

[1] Tyndall National Institute, University College Cork, Cork, Ireland,

[2] School of Chemistry, University College Cork, Ireland,

[3] School of Chemistry, AMBER and CRANN, Trinity College Dublin, Dublin 2, Ireland

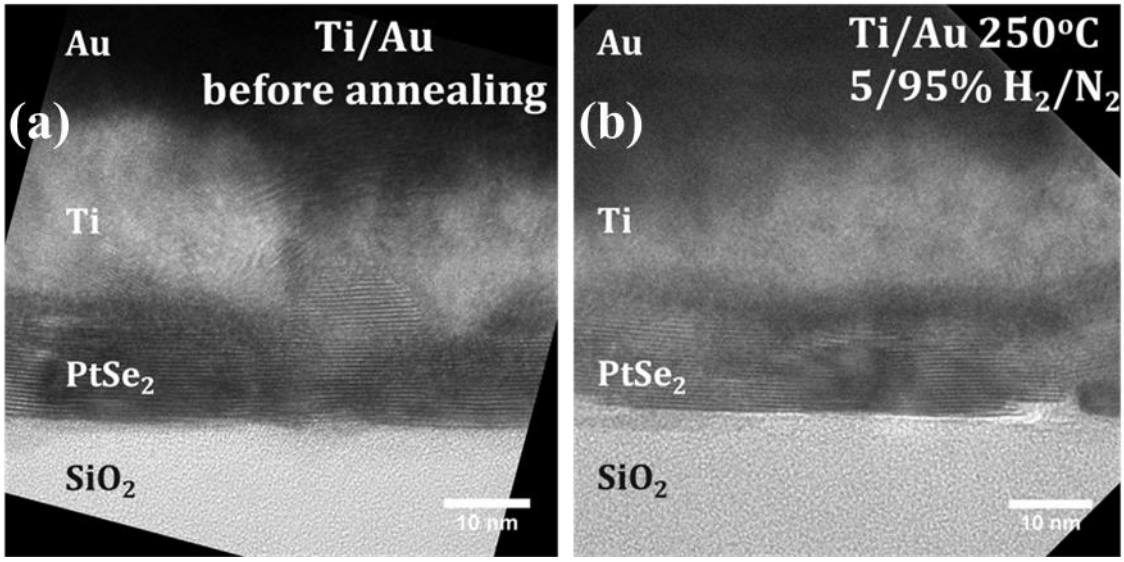

Figure S1: Representative cross-section TEM images of the $PtSe_2$ contacted with Ti/Au (a) before and (b) after annealing at 250 °C in FG, showing that the layered structure of the $PtSe_2$ is maintained after annealing.

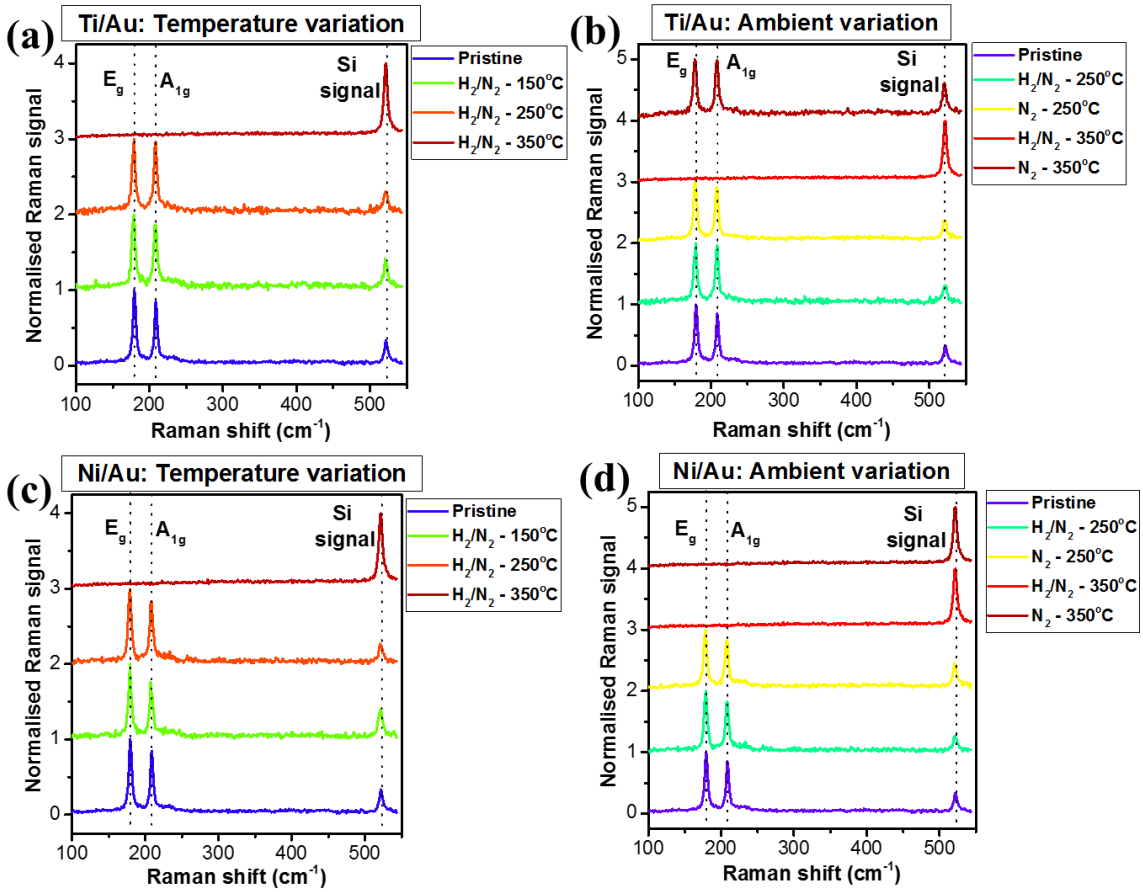

Figure S2: Raman signal collected from the $PtSe_2$ region (not the alloy region) after each annealing variation. (a) and (c) show the Raman signal after annealing in forming gas for each temperature for the Ti/Au and Ni/Au samples respectively. (b) and (d) show the Raman signal after annealing at 250 °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 $PtSe_2$ signal is lost.

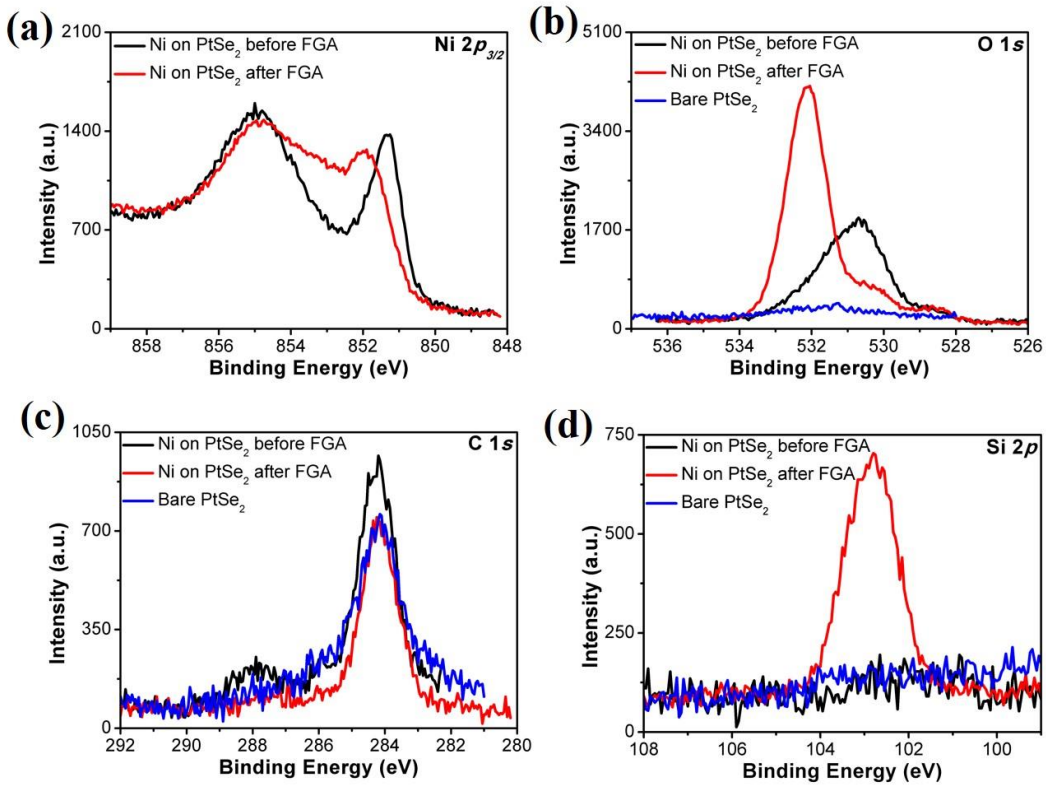

Figure S3: Additional XPS spectra of as-deposited Ni/$PtSe_2$ samples. a) Ni $2p_{3/2}$, (b) O 1*s*, (c) C 1*s*, and (d) Si 2*p* spectra.

Figure S2 shows spectra of the as-deposited Ni on $PtSe_2$ 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 $NiSe_x$ due to the number of complex satellite peaks present at higher BE in a Ni 2*p* 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 $PtSe_2$) following Ni deposition. This is primarily due to oxidation of the Nickel surface. No significant change in the C 1*s* or Si 2*p* signal is observed between bare $PtSe_2$ and Ni on $PtSe_2$, indicating no C contamination, or thinning of the $PtSe_2$ layer (which would lead to an increased Si signal).

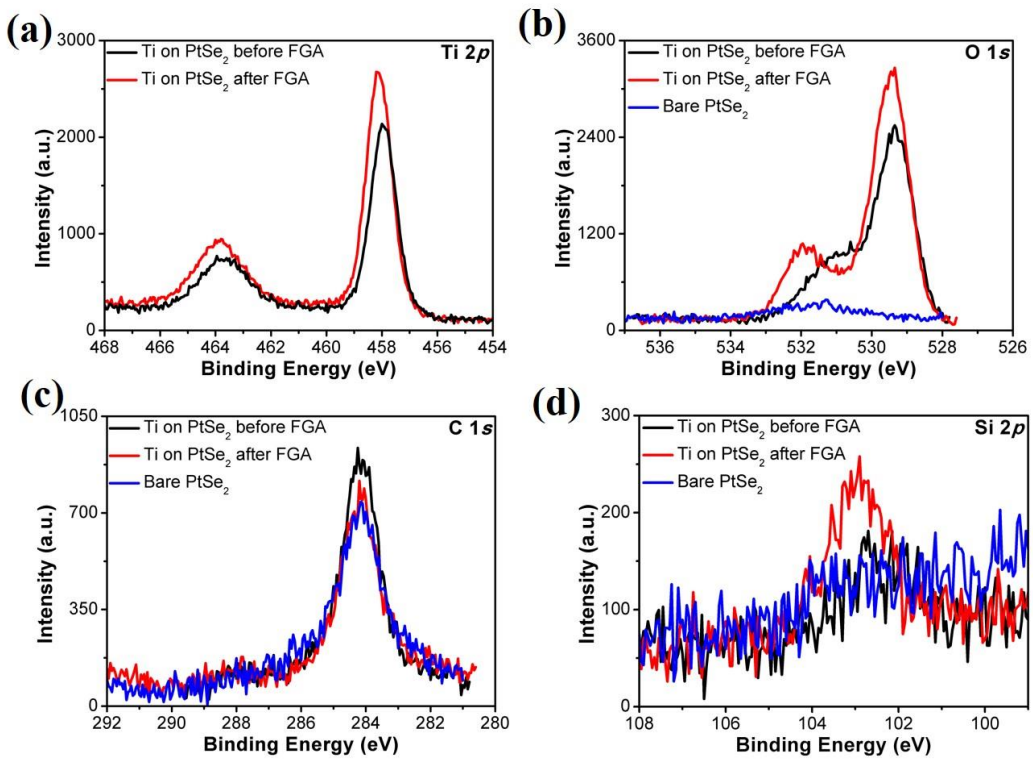

Figure S4: Additional XPS spectra of as-deposited Ti/$PtSe_2$ samples. a) Ti 2*p*, (b) O 1*s*, (c) C 1*s*, and (d) Si 2*p* spectra.

Figure S3 shows additional spectra of the as-desposited Ti on $PtSe_2$. The Ti 2*p* spectra show a no evidence of a metallic Ti signal rather the peak shape and position are that expected for TiO_2. This is expected given the very low formation energy of TiO_2, 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 2*p* signal is observed between bare $PtSe_2$ and Ti on $PtSe_2$, again indicating no C contamination, or thinning of the $PtSe_2$ layer.