# Supplementary Information

## Optical and thermal response of silicene in a Xene heterostructure

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**S1.** ***In-situ*** **LEED characterization**

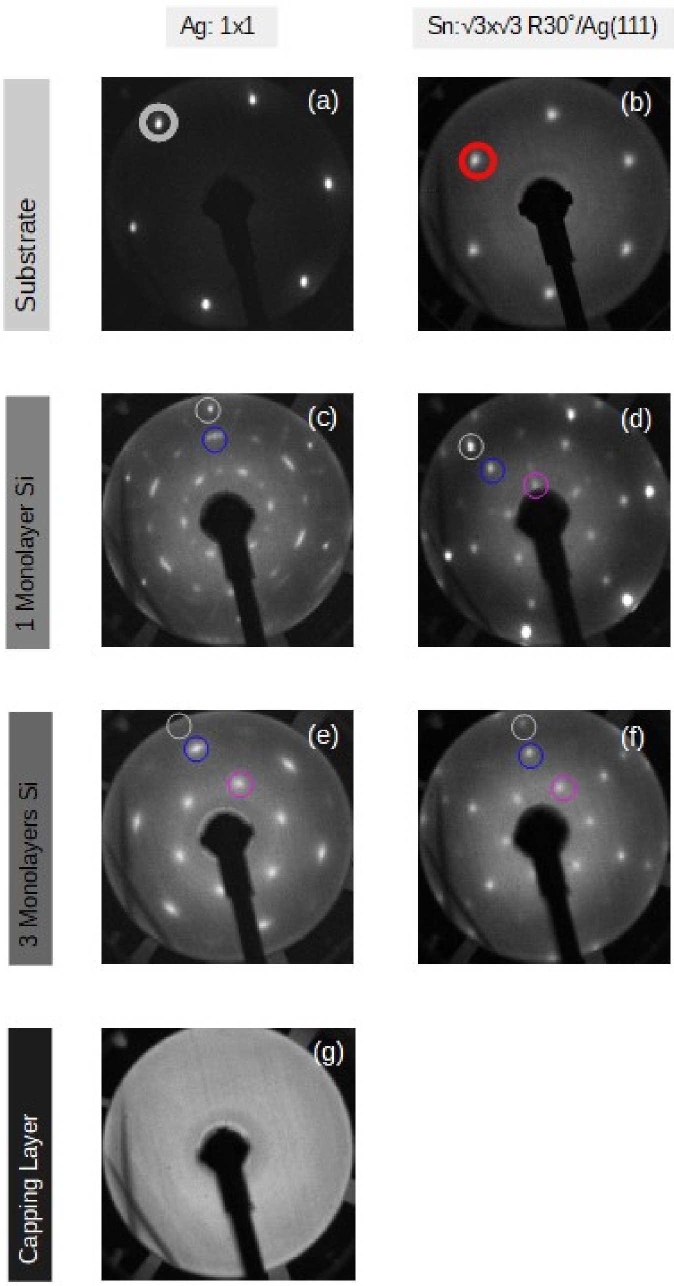
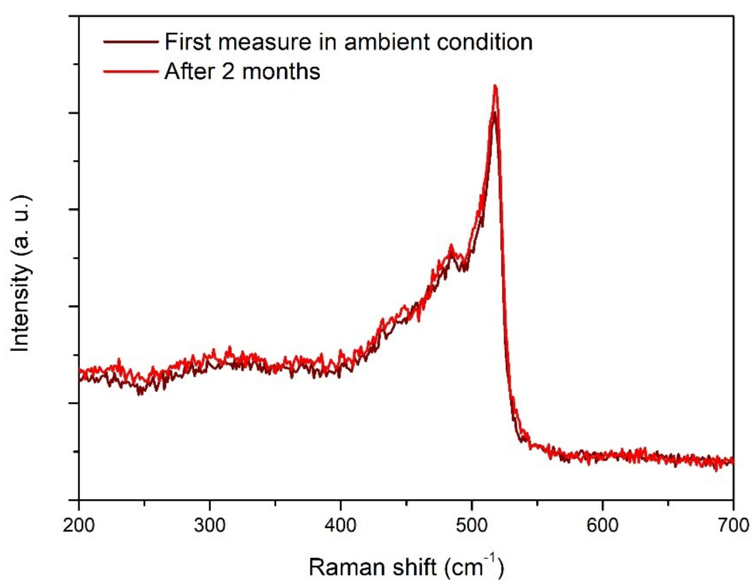


**Figure S1:** LEED patterns obtained for: substrate templates (a) Ag:1x1 and (b) stanene: $\sqrt{3}$x$\sqrt{3}$ R30° on Ag(111), (c) monolayer silicene grown on Ag(111), (d) monolayer silicene grown on stanene-Ag(111), (e) multilayer silicene grown on Ag(111), (f) multilayer silicene grown on stanene-Ag(111), (g) amorphous and non-reactive $Al_2O_3$ capping layer. Color coding of solid circles: gray - Ag:1x1, red - $\sqrt{3}$x$\sqrt{3}$ R30° order Sn spots, blue - integer order Si spots, pink - $\sqrt{3}$x$\sqrt{3}$ R30° order Si spots with respect to the integer order Si spots inside solid blue circles. The incident energy during LEED image acquisition is 50 eV except for (b), where the energy used is 33 eV.

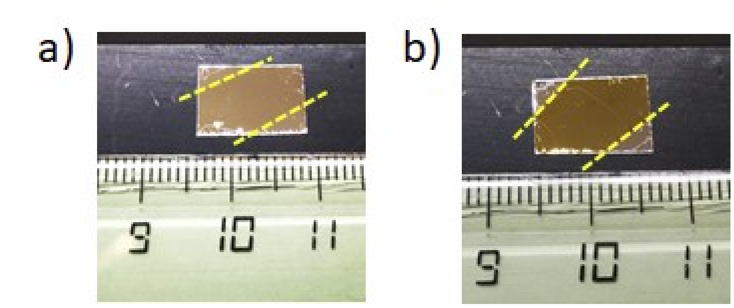
**S2. Stability of encapsulated silicene**

The deposited Xenes were capped with an amorphous and non-reactive $Al_2O_3$ layer before the exposure to ambient conditions. The effectiveness of the $Al_2O_3$ capping layer in protecting the silicene against degradation has been extensively reported in ref. [1][2]. To our knowledge, protection by $Al_2O_3$ encapsulation provide an undeterminably




durable preservation of each type of produced samples.

**Figure S2:** Room temperature Raman spectra of single layer of silicene on Ag(111) (dark) after the growth and (light) after two months of air exposure.




**S3. Optical images**

**Figure S3:** Optical images of (a) silicene on Ag(111) and (b) silicene on stanene-Ag(111). Dashed yellow lines indicate the growth area.

**S4. Reversibility of laser-induced effects**

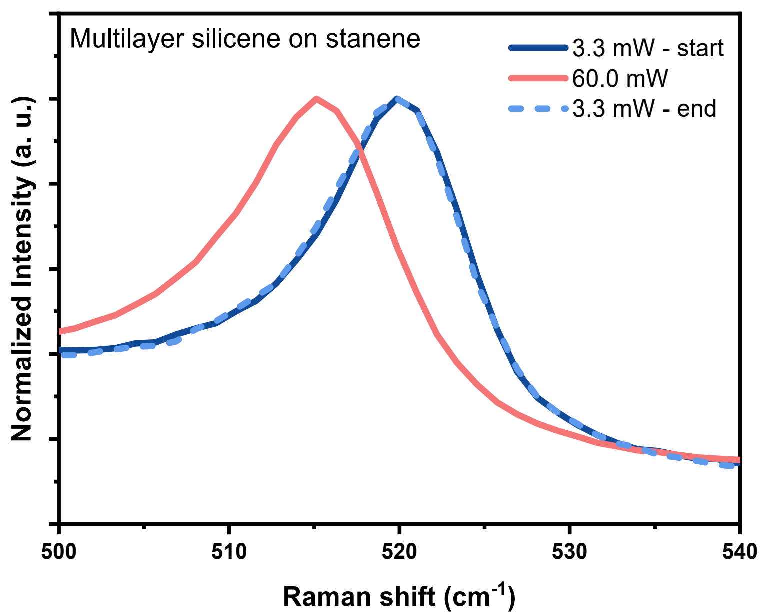
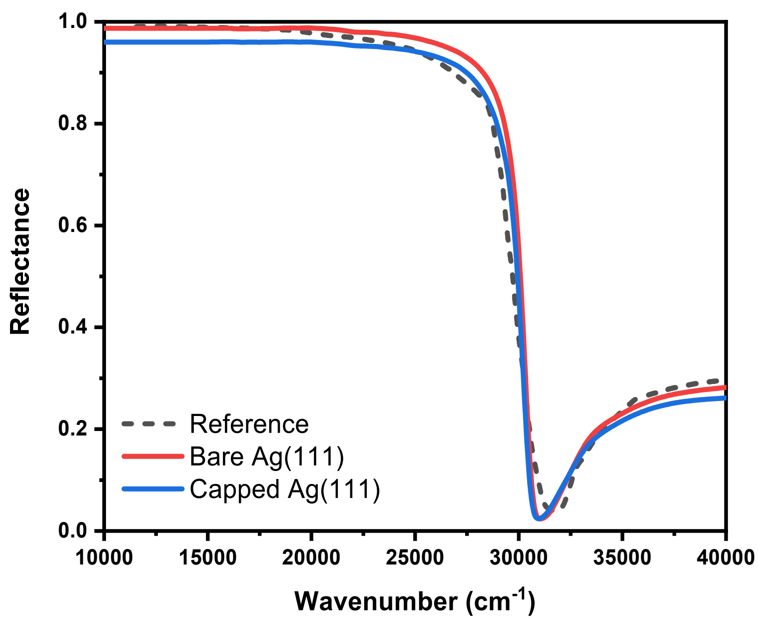



**Figure S4:** Normalized Raman spectra of the multilayer silicene on stanene/Ag(111) acquired at 3.3, at 60 and then again at 3.3 mW of laser power. The return of the Raman peak to its initial position demonstrates the absence of laser-induced structural changes.

**S5. Capping layer effects on substrate optical properties**

For bare (red line) and capped silver (blue line), the near-unity reflectance approaches zero around 30000 cm-1 (3.8 eV), in good agreement with what is expected of bulk silver (black line). Real and imaginary components of the dielectric functions, obtained from a spectral analysis Kramers-Kronig constrained, are also in good agreement with each other. This is a further demonstration that the encapsulation procedure does not affect the optical properties of the system at all, even when considering a very surface-sensitive experimental technique such as optical




spectroscopy in reflection geometry.

**Figure S5:** Reflectance of bare and capped silver compared with data reported in ref.[3]

REFERENCES

1) Grazianetti et al., Nano Lett. 18, 7124 (2018)

2) Molle et al., Faraday Discuss. DOI: 10.1039/C9FD00121B

3) Palik, E. D. Handbook of Optical Constants of Solids. **1991**, 1117