ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Optospintronics in van der Waals structures

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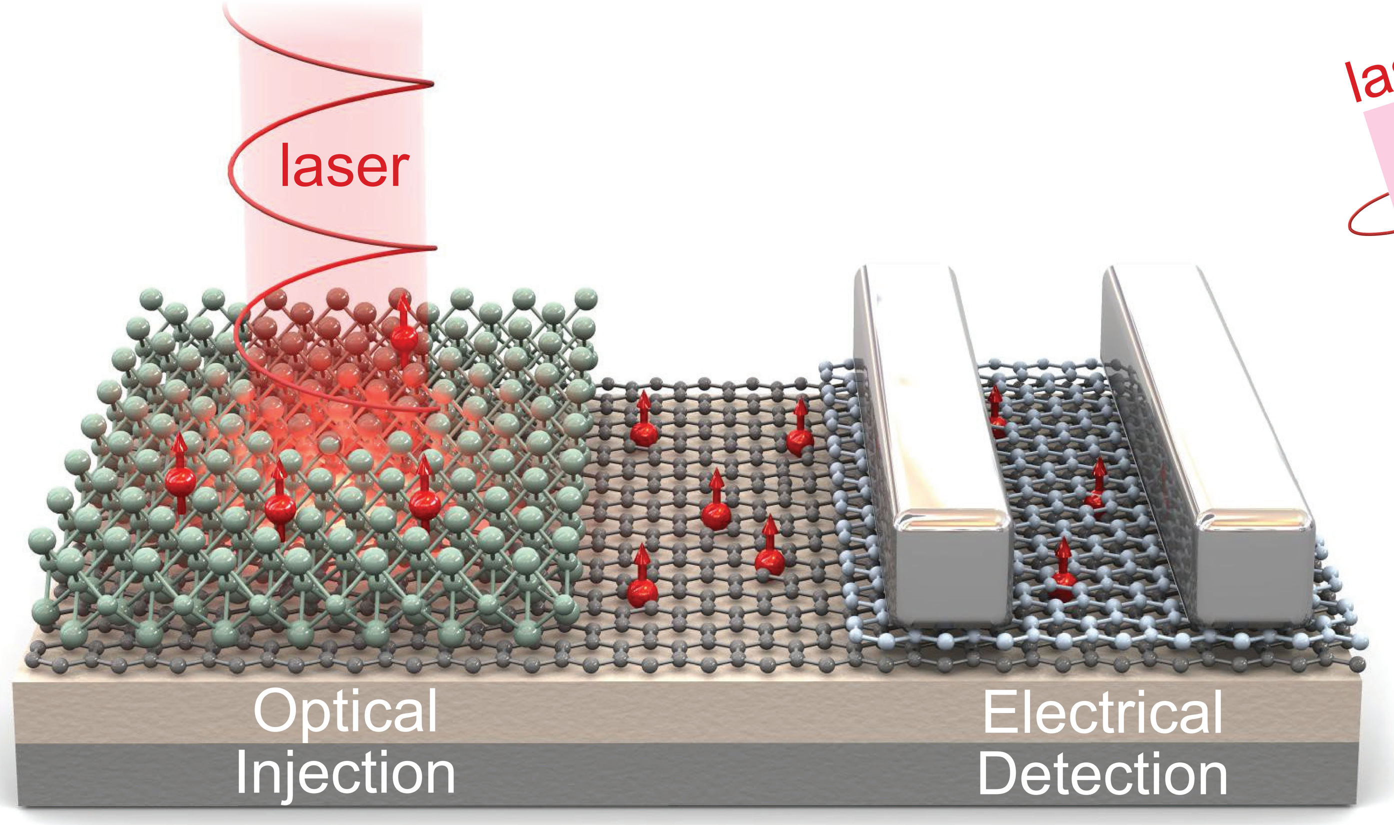
LABORATORY OF NANOSCALE ELECTRONICS AND STRUCTURES

1. Introduction

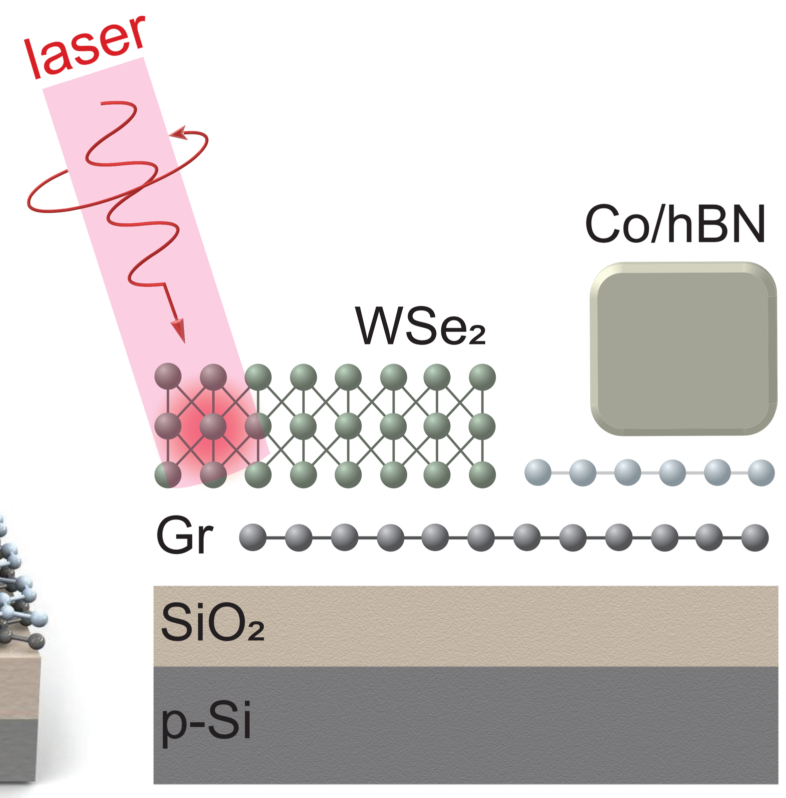
We demonstrate here possibility of nondestructive direct optical spin injection into graphene through a 2D semiconducting monolayer crystal, by following scheme:

- Circularly polarized light selectively addresses carrier valley degree of freedom in the monolayer WSe2 crystal;
- Spin-valley locking in the crystal with broken inversion symmetry leads to non-equilibrium spin concentration;
- Carriers tunnel into the superjacent graphene layer and diffuse over a 3.5 μm distance;
- Spin transport is detected electrically using Co/hBN contacts in a nonlocal geometry.

2. Device structure

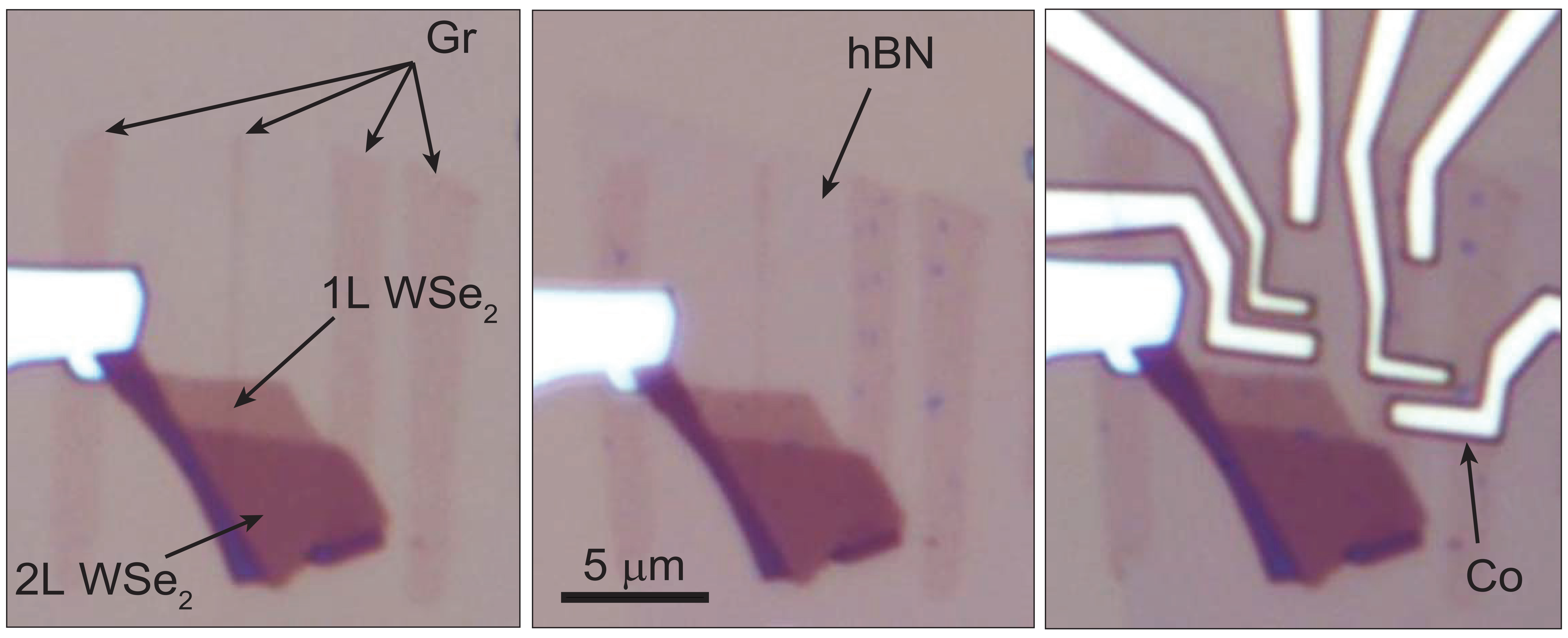


Optical spin injection in WSe_2/Graphene



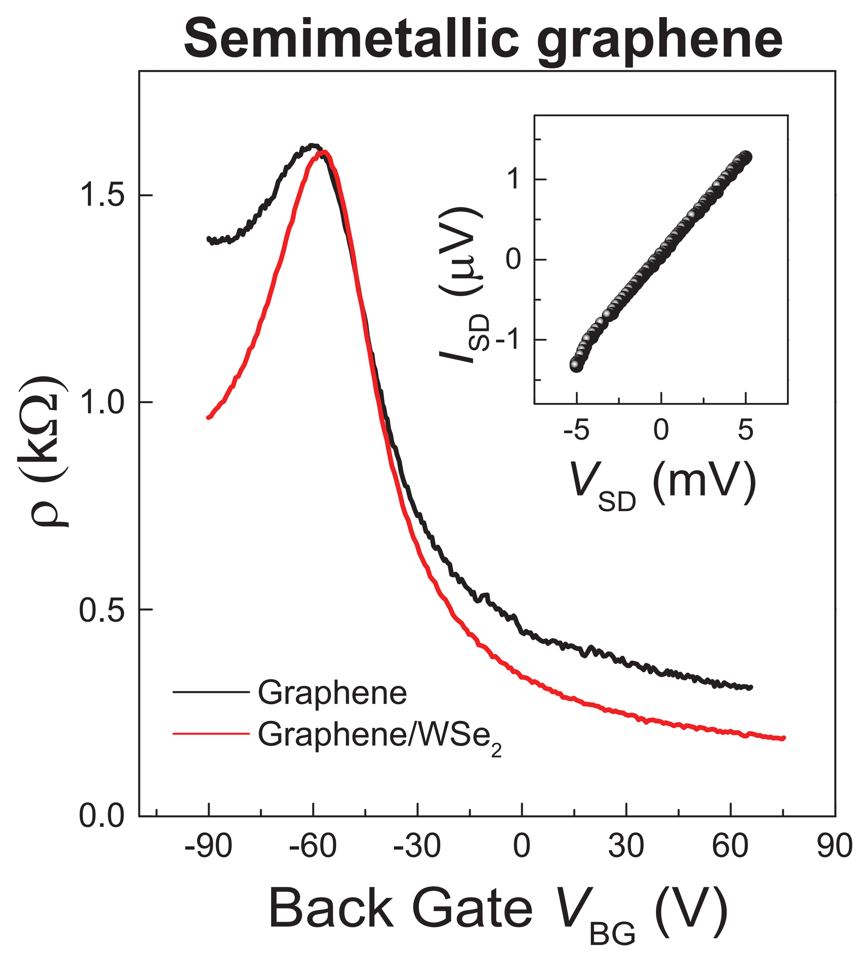
Cross-section

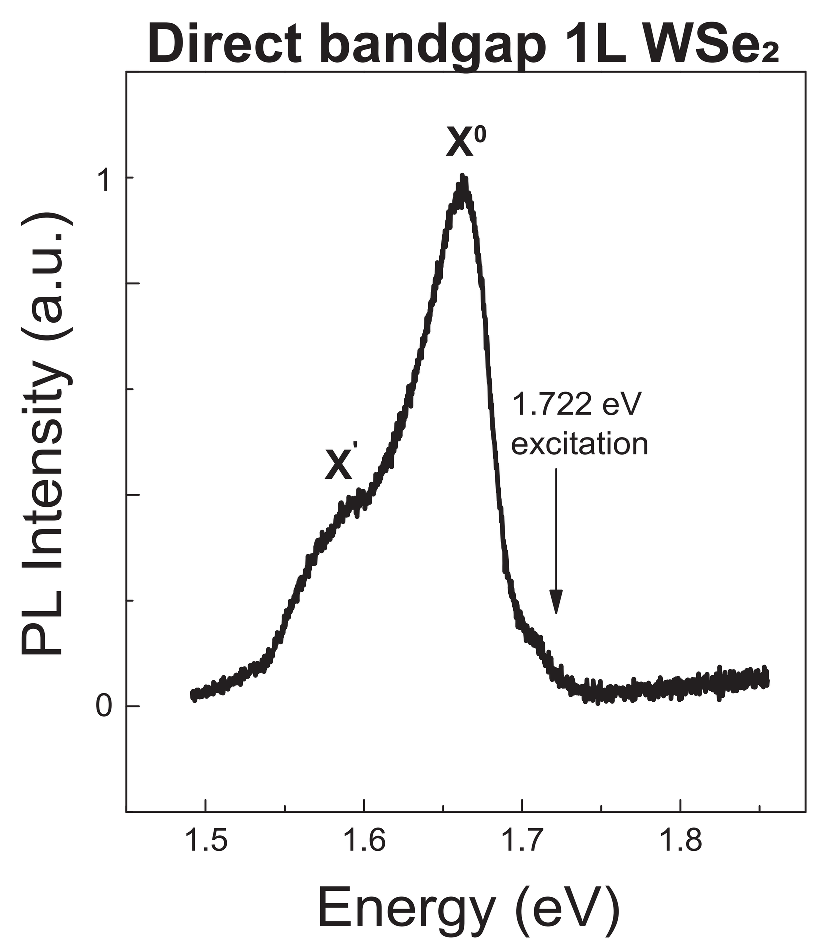
3. Device microfabrication



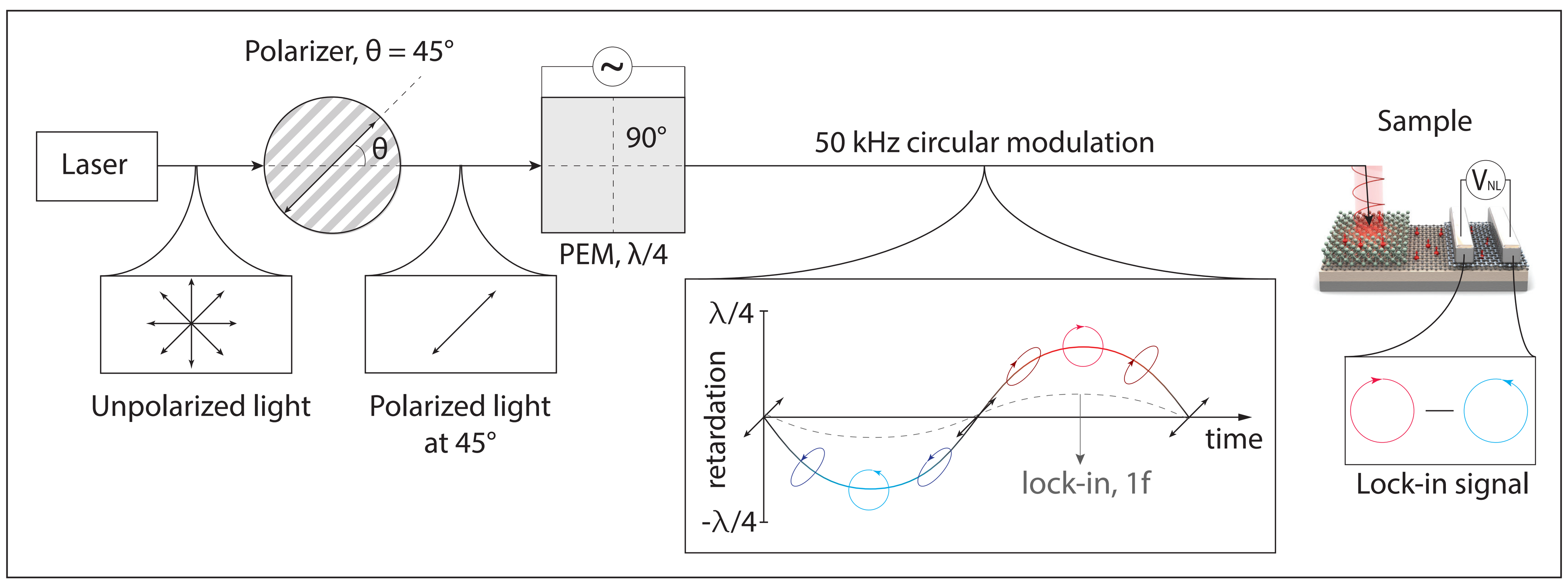
Transfer of graphene on WSe_2 | hBN encapsulation | E-beam lithography Contacts metallization

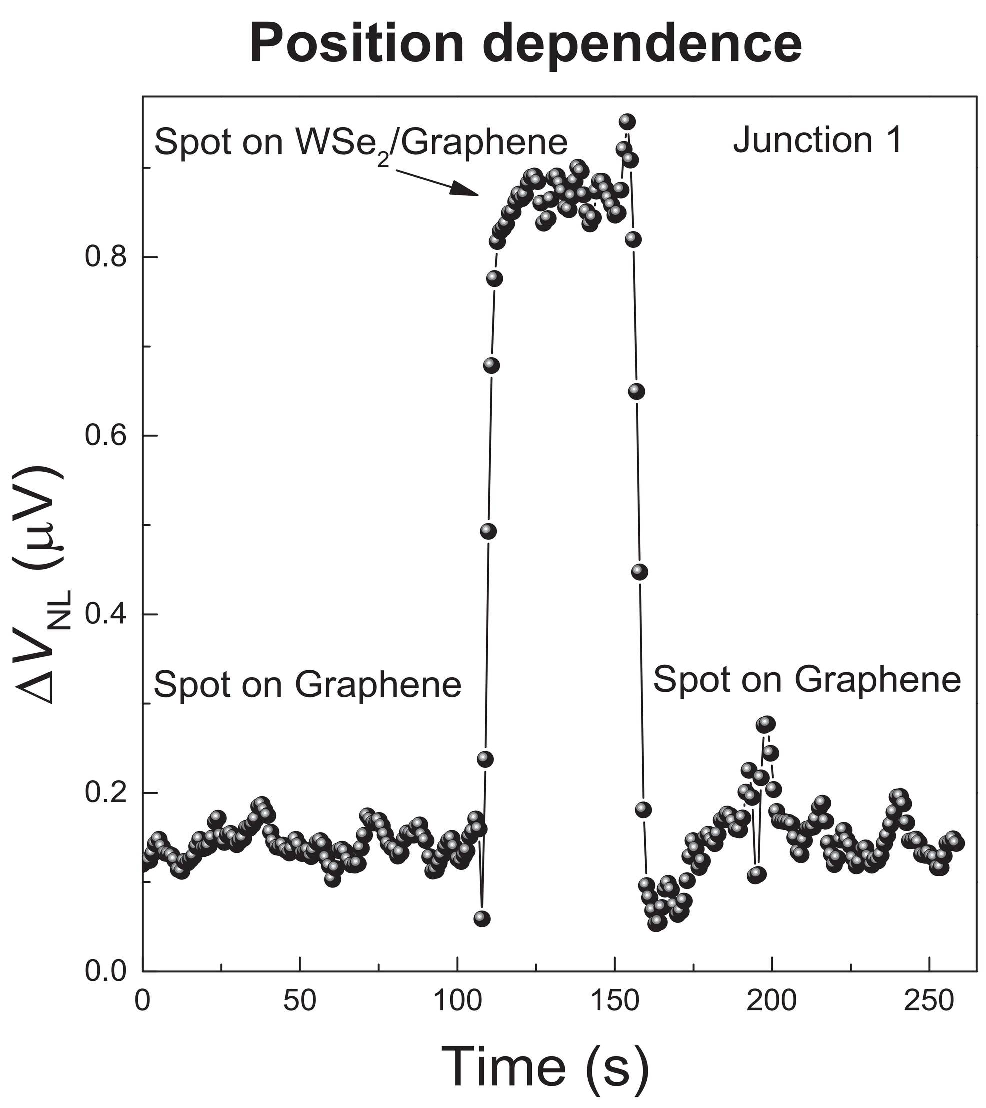
4. Material characterisation

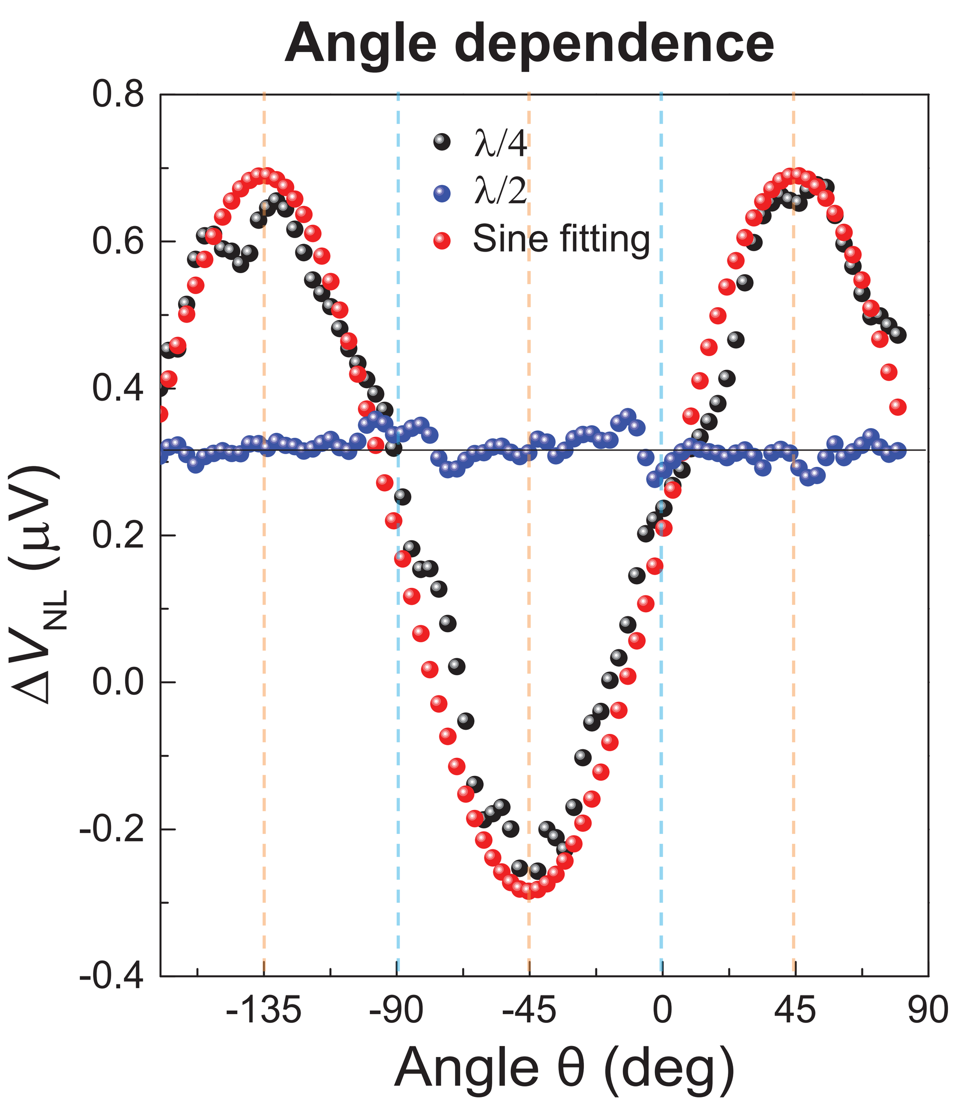


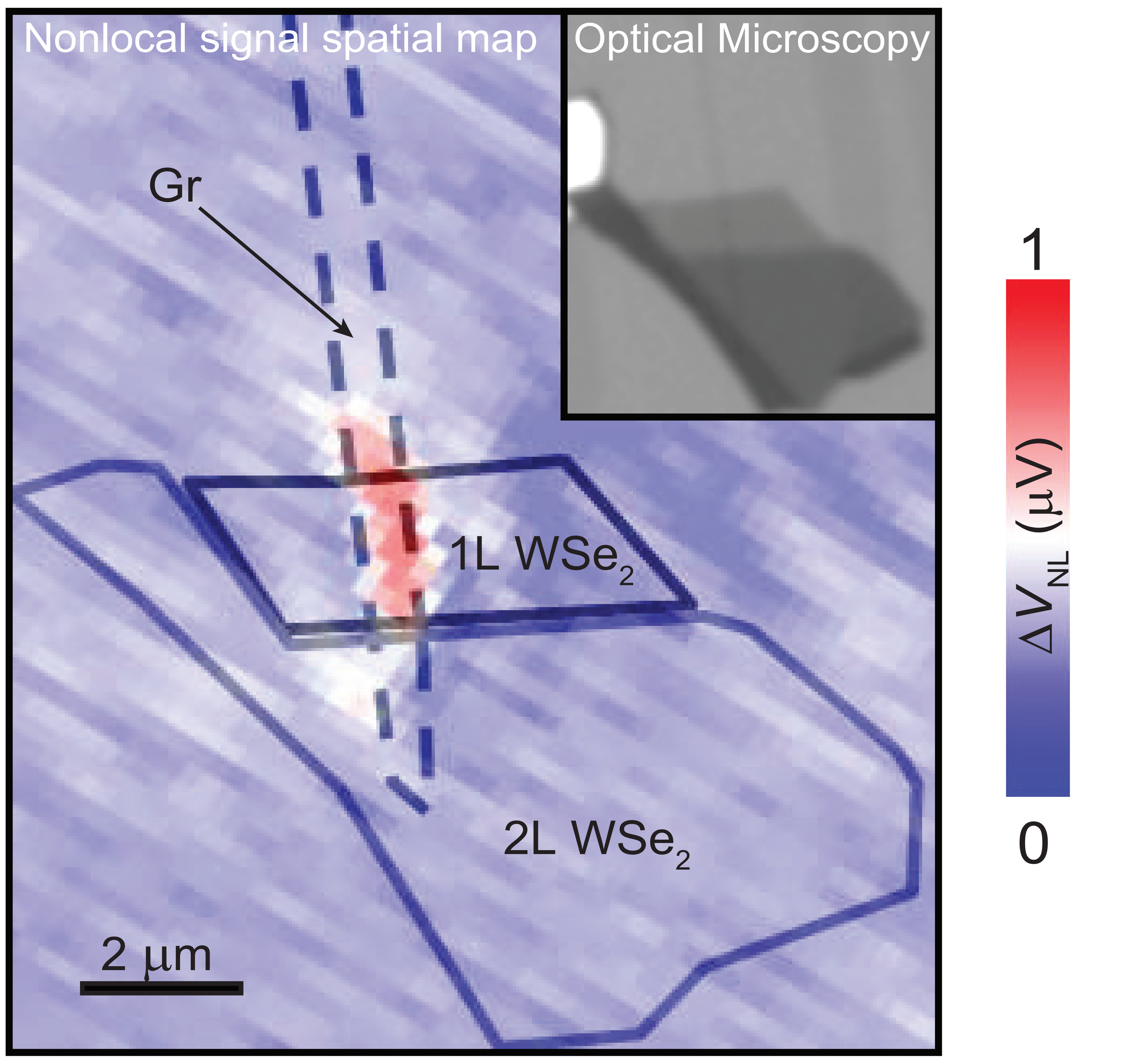


5. Optospintronic measurements









Circularly modulated light focused on the WSe_2 results in nonlocal spin signal detected by lock-in amplifier. We obtain following results:

- Well pronounced nonlocal signal from the heterostructure region
- Neither bilayer WSe_2 nor graphene alone shows spin signal
- Linear power dependency up to 8 mW incident laser intensity
- Absence of the signal in the case of linearly polarized light

6. Conclusion

- Demonstration of the first optical spin injection in graphene by exploiting spin-valley selective absorption of monolayer WSe_2.
- Angle dependence measurements together with the absence of non-local signal at the bilayer WSe_2/graphene interface proves spin-coupled, valley-selective origin of the observed signal.

Acknowledgement

GRAPHENE FLAGSHIP
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Reference

Ahmet Avsar, Dmitrii Unuchek, et al. Optospintronics in Graphene via Proximity Coupling. ACS Nano 11, 11678–11686 (2017). DOI: 10.1021/acsnano.7b06800