

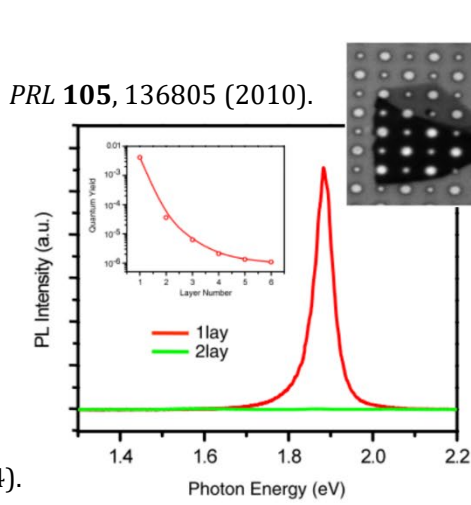
Strain Switching in van der Waals Heterostructures Triggered by a Spin-Crossover Metal–Organic Framework.

Carla Boix Constant

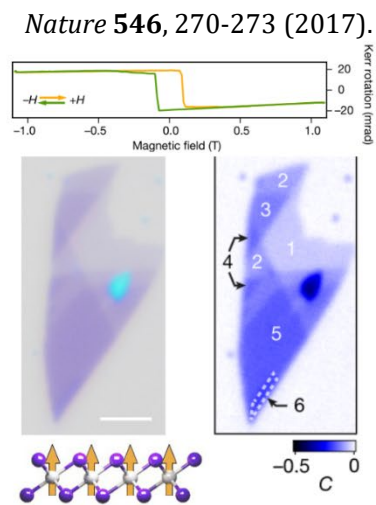
Research Team on Molecular Materials
Instituto de Ciencia Molecular (ICMol) – University of Valencia
Workshop on 2D materials – 23/05/2024



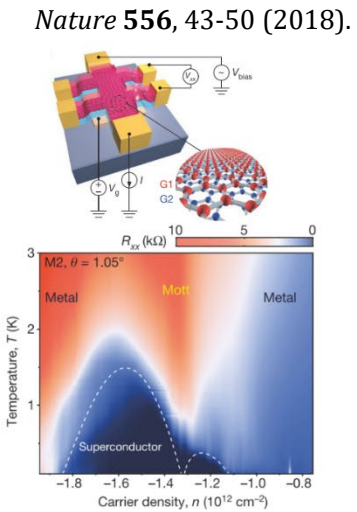
2D materials



MoS₂ (2010)

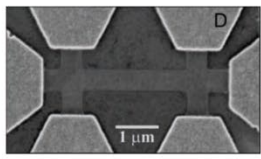


CrI₃ (2017)



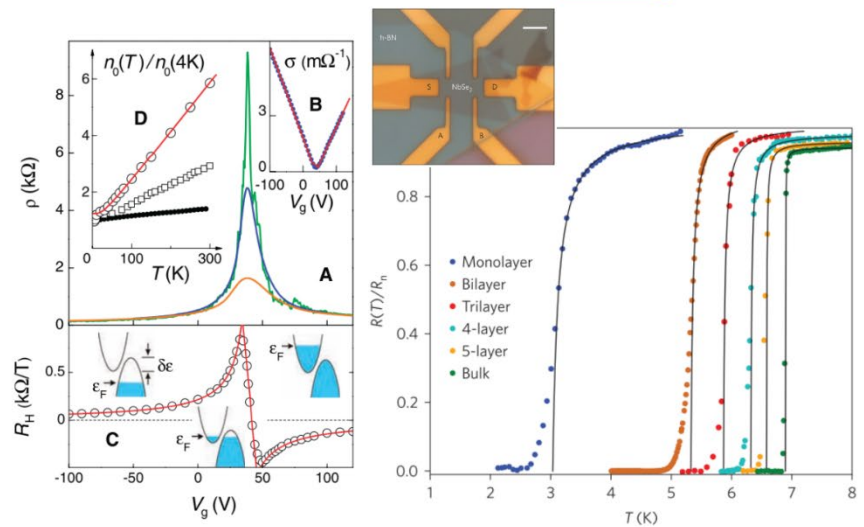
MATBG (2018)

Science 306, 666 - 669 (2004).



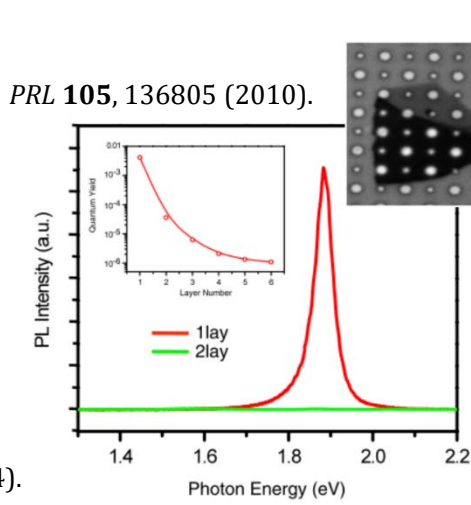
Graphene (2004)

NbSe₂ (2016)

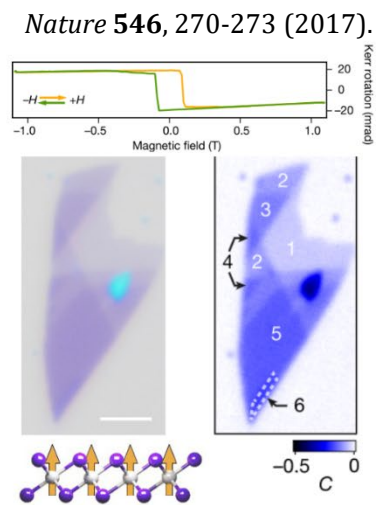


Nat. Phys. 12, 139-143 (2016).

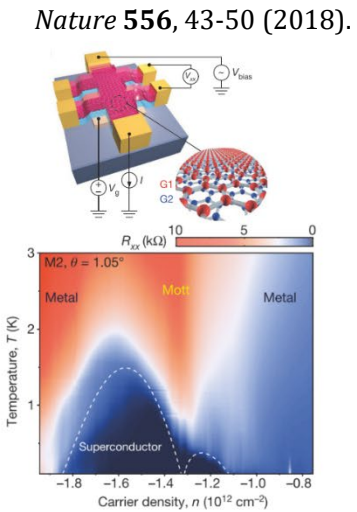
2D materials



MoS₂ (2010)

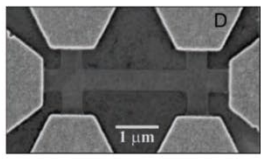


CrI₃ (2017)



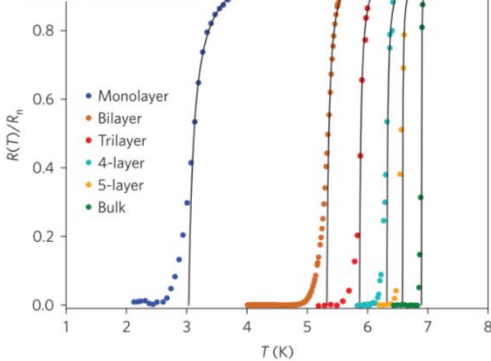
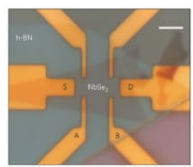
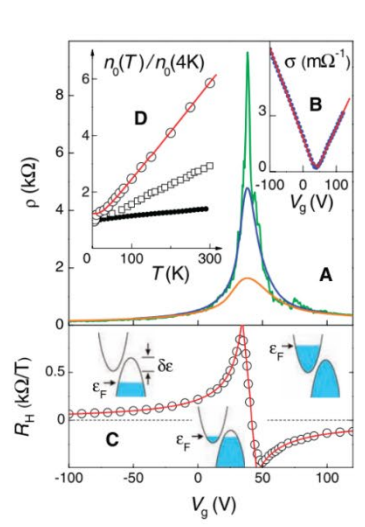
MATBG (2018)

Science 306, 666 - 669 (2004).



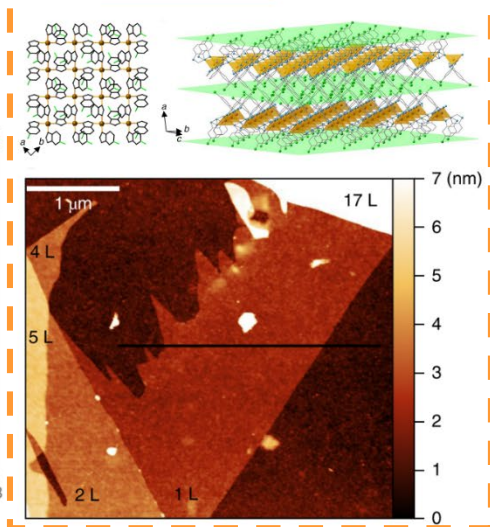
Graphene (2004)

NbSe₂ (2016)



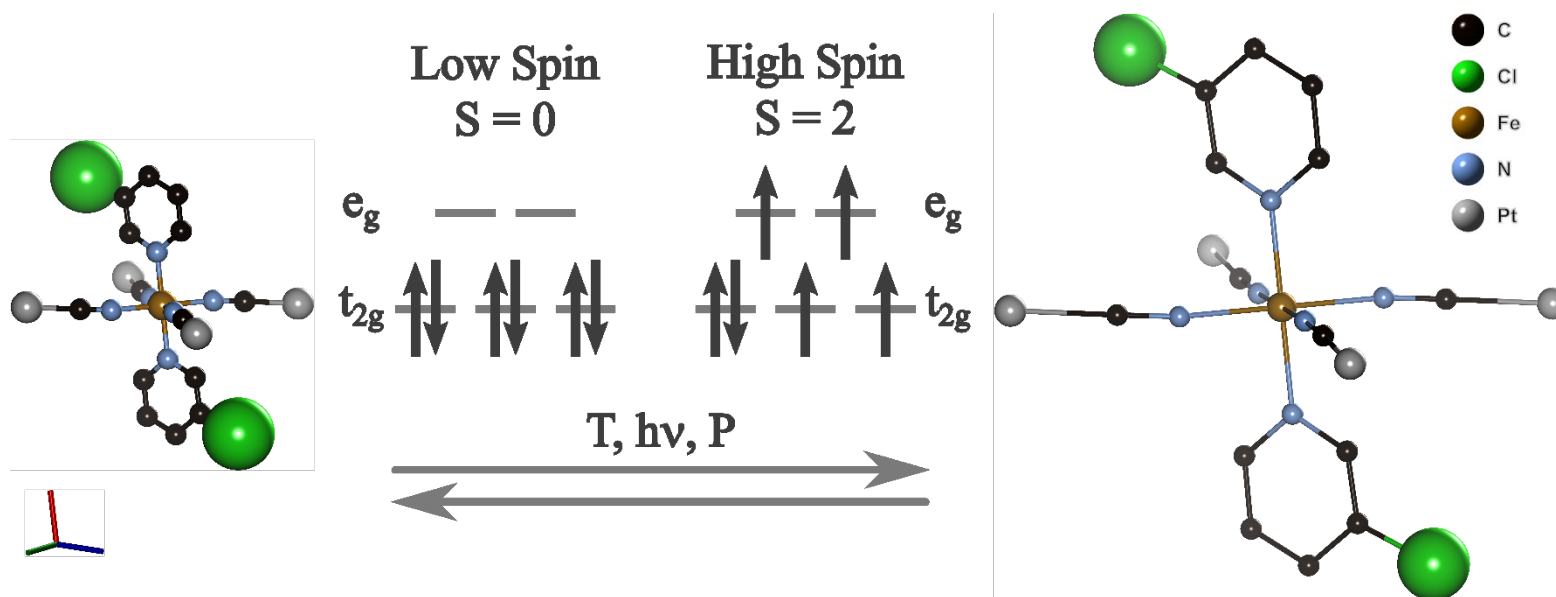
Nat. Phys. 12, 139-143 (2016).

MUV-1-Cl (2018)

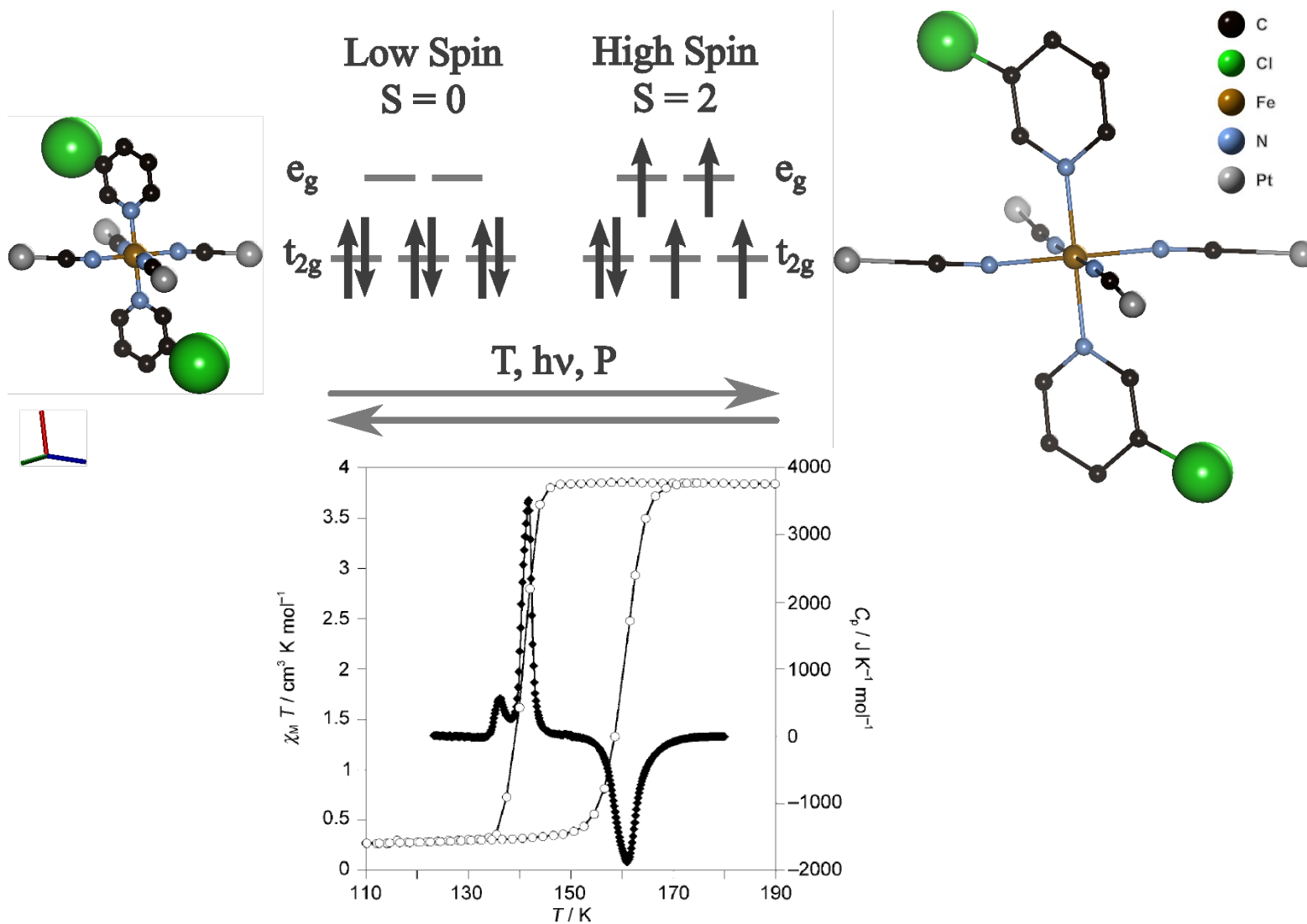


Nat. Chem. 10, 1001-1007 (2018).

Spin-crossover systems

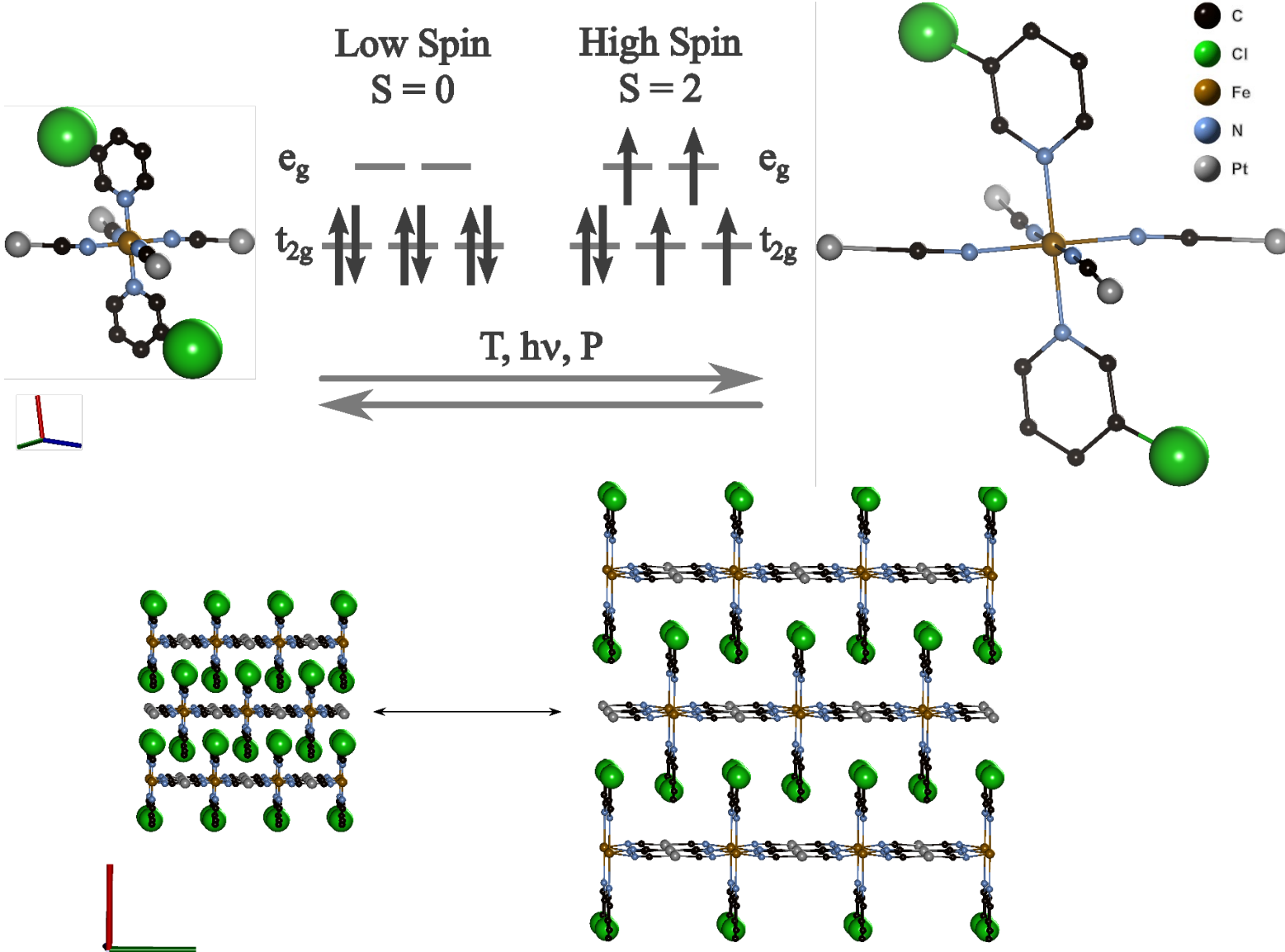


Spin-crossover systems

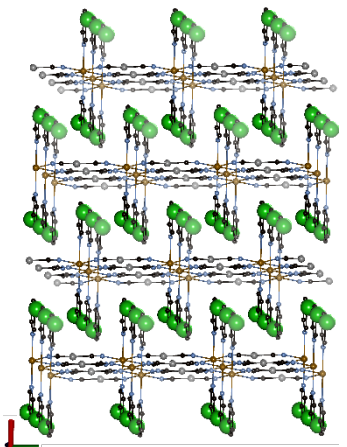
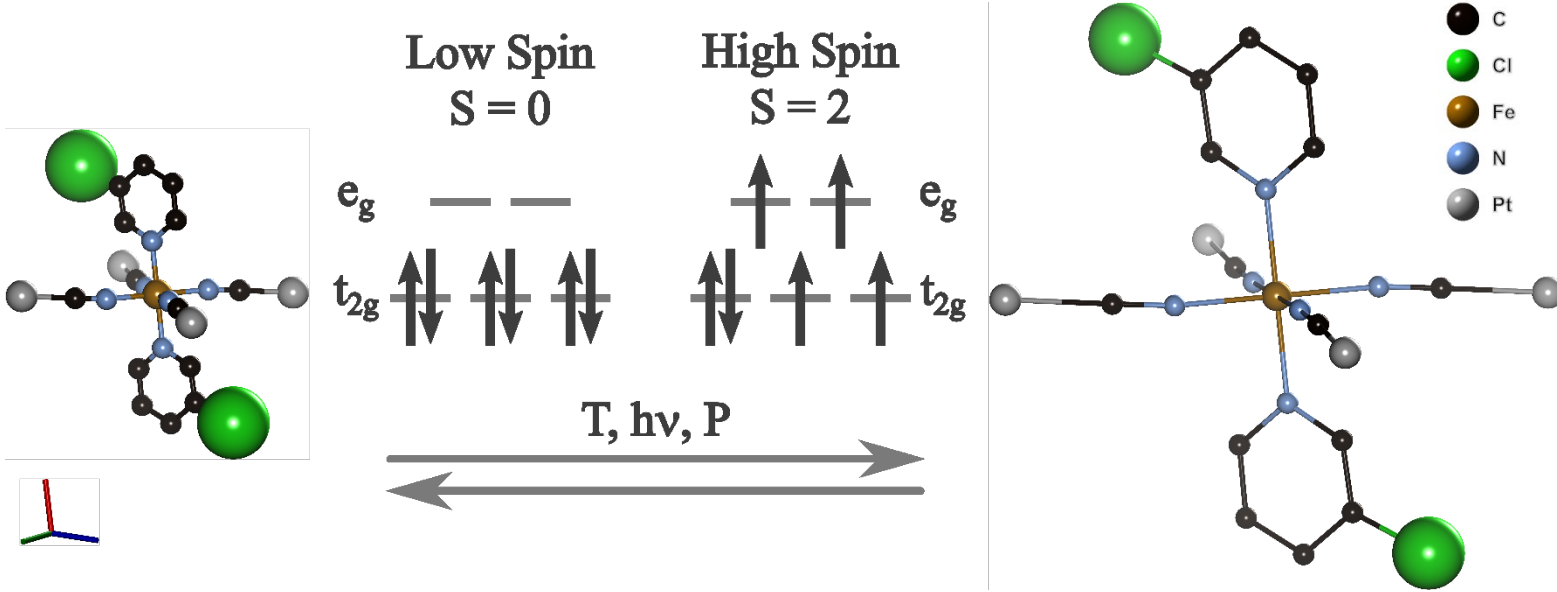


Chem. Eur. J. **15**, 10960 - 10971 (2019).

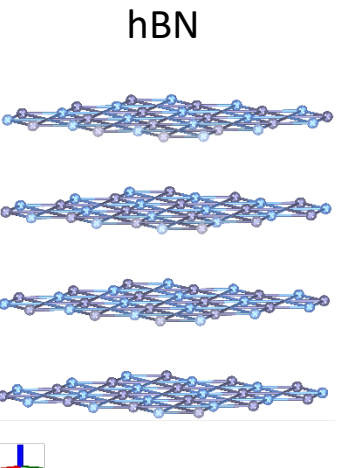
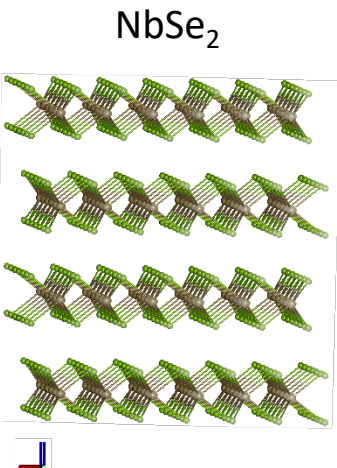
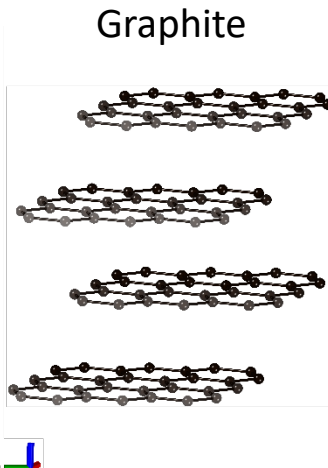
Spin-crossover systems



Spin-crossover systems

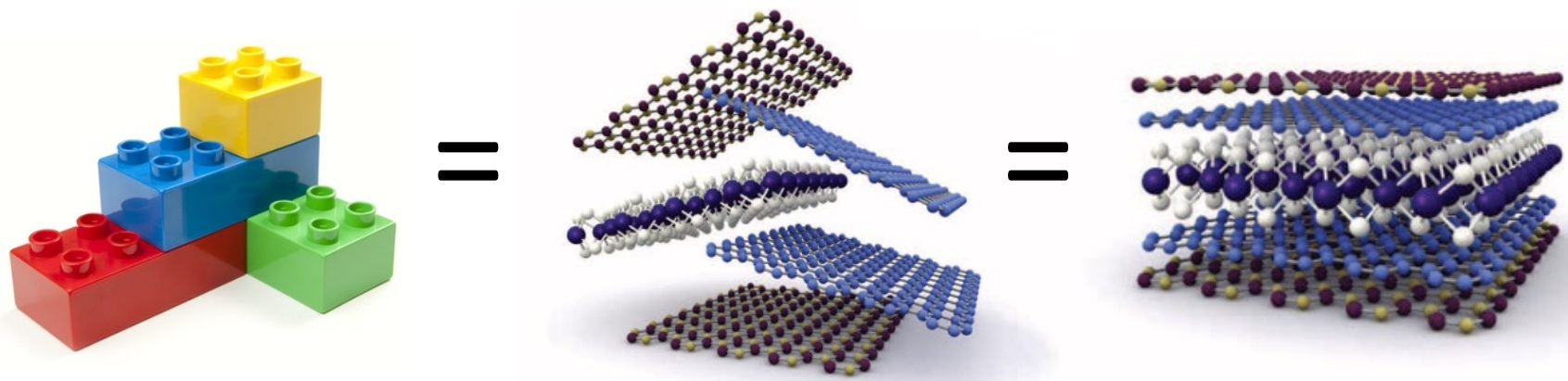
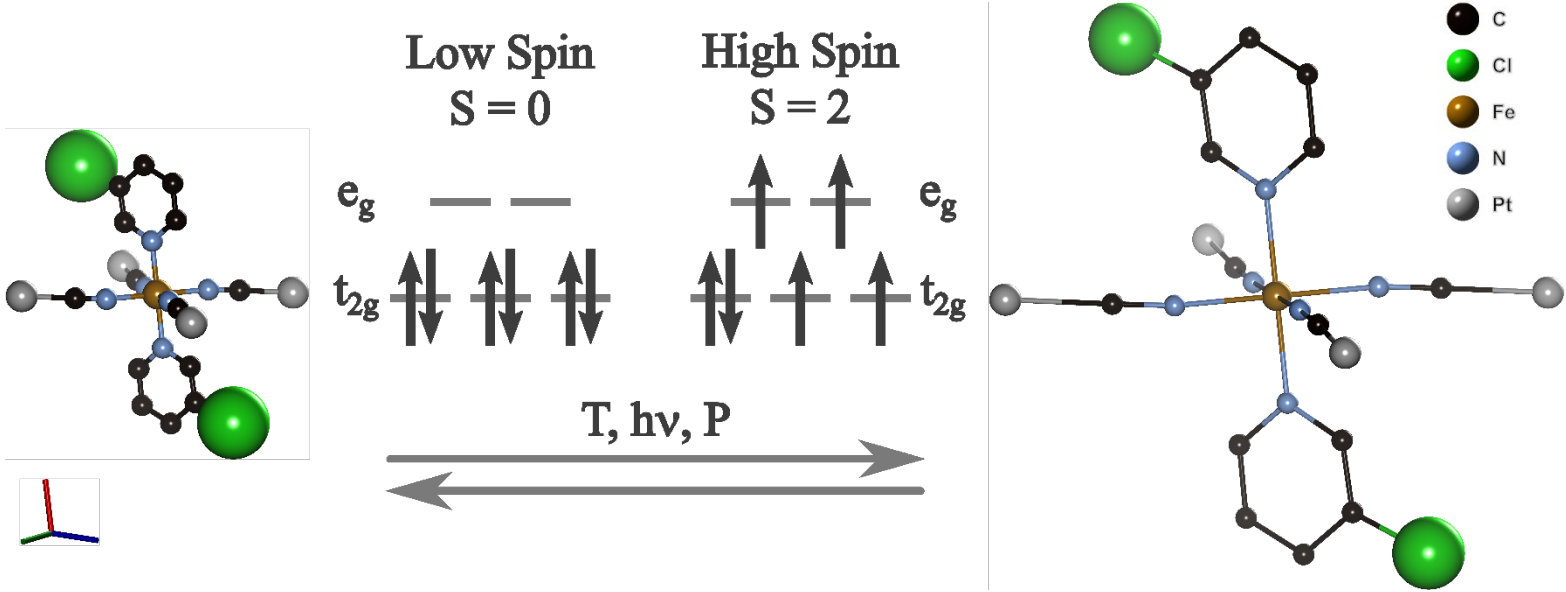


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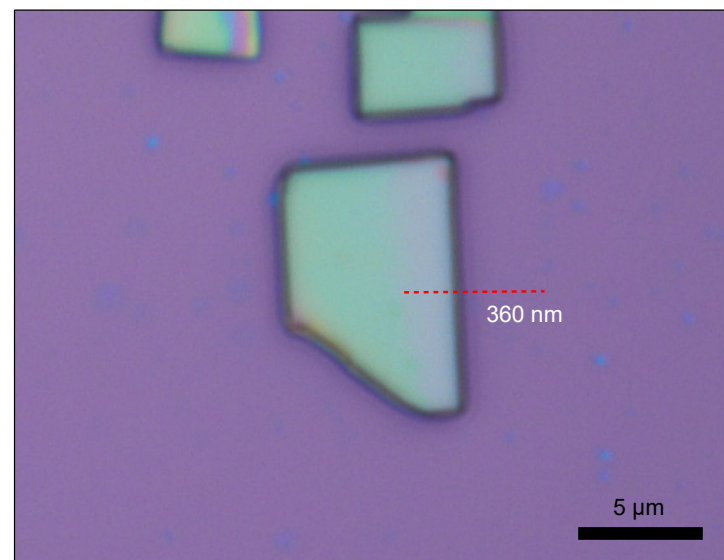
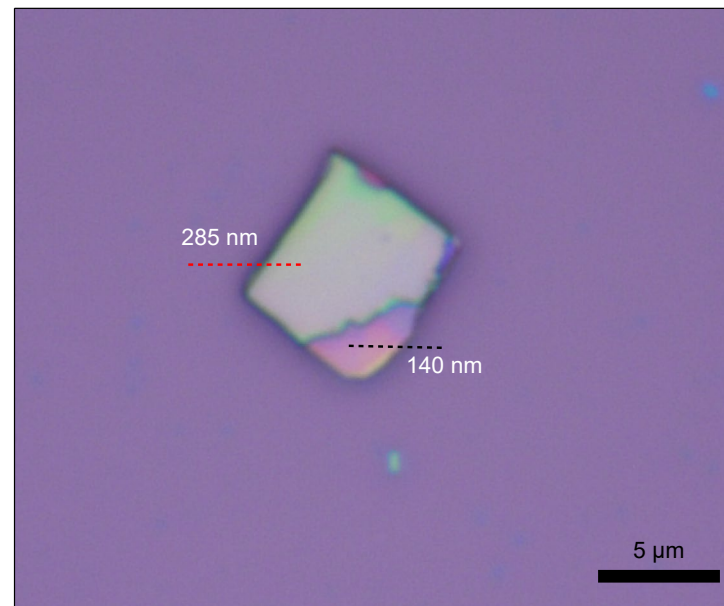
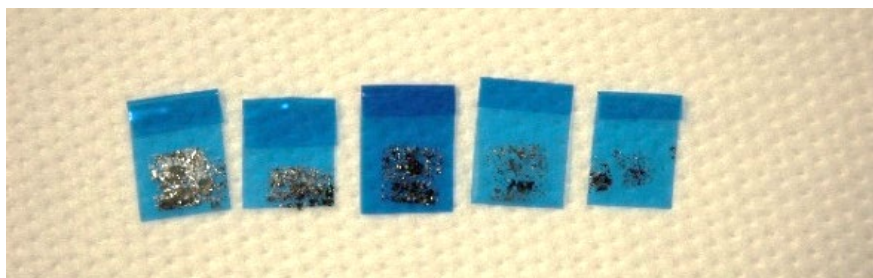
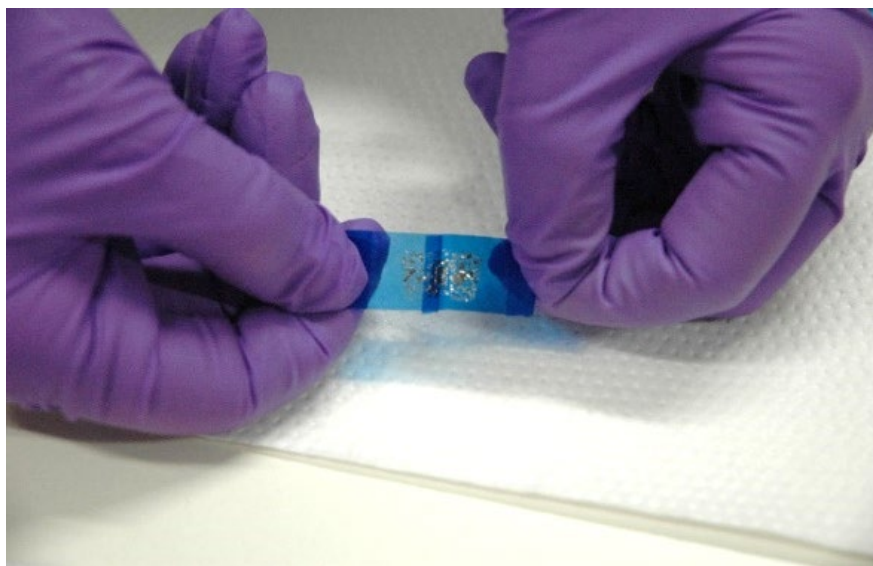


= ?

2D materials: hybrid inorganic/molecular van der Waals heterostructures.



Mechanical exfoliation



Optical contrast

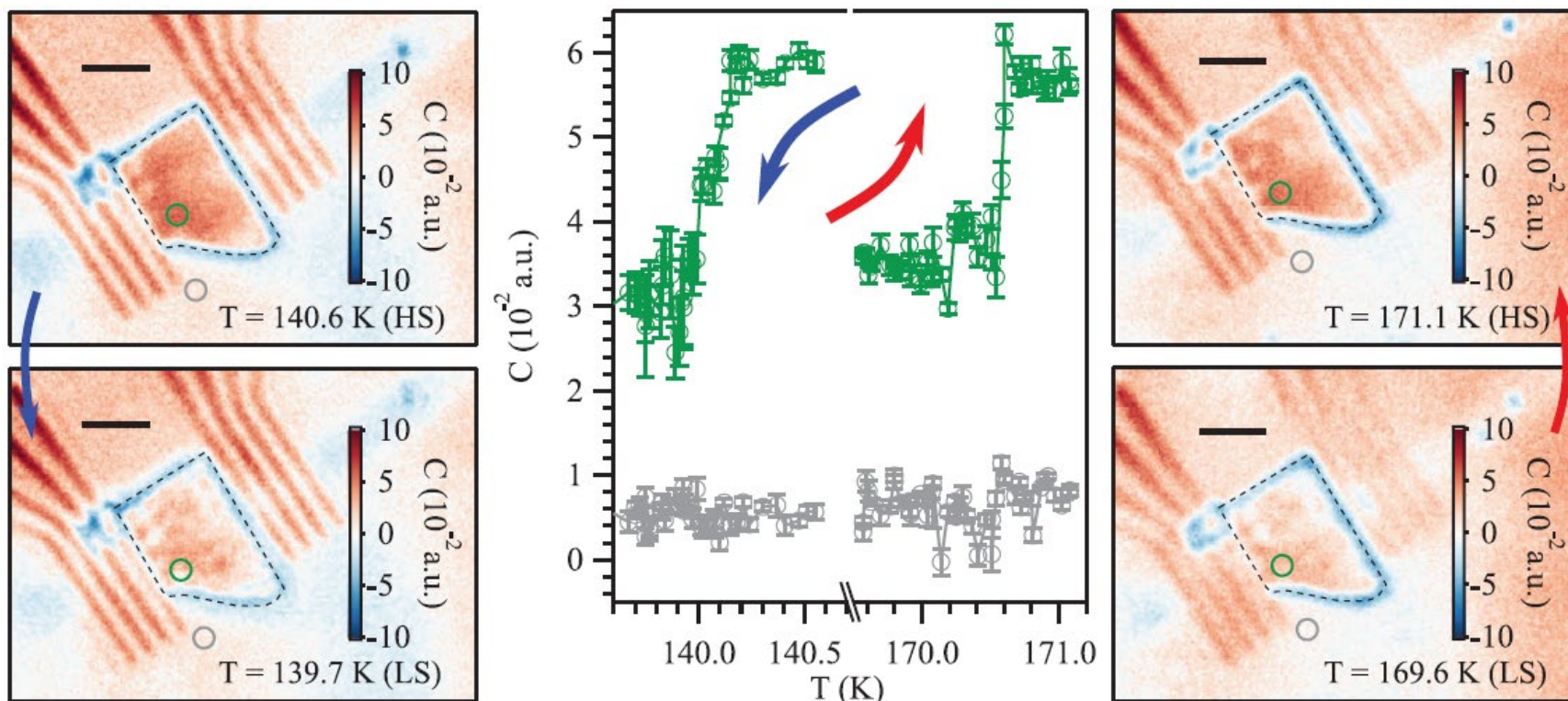
We can identify thin layers thanks to their **optical contrast** on SiO₂ substrates.

★ **Experimental contrast:**
$$C(d, \lambda) = \frac{I_{\text{flake}} - I_{\text{SiO}_2}}{I_{\text{flake}} + I_{\text{SiO}_2}}$$

Optical contrast

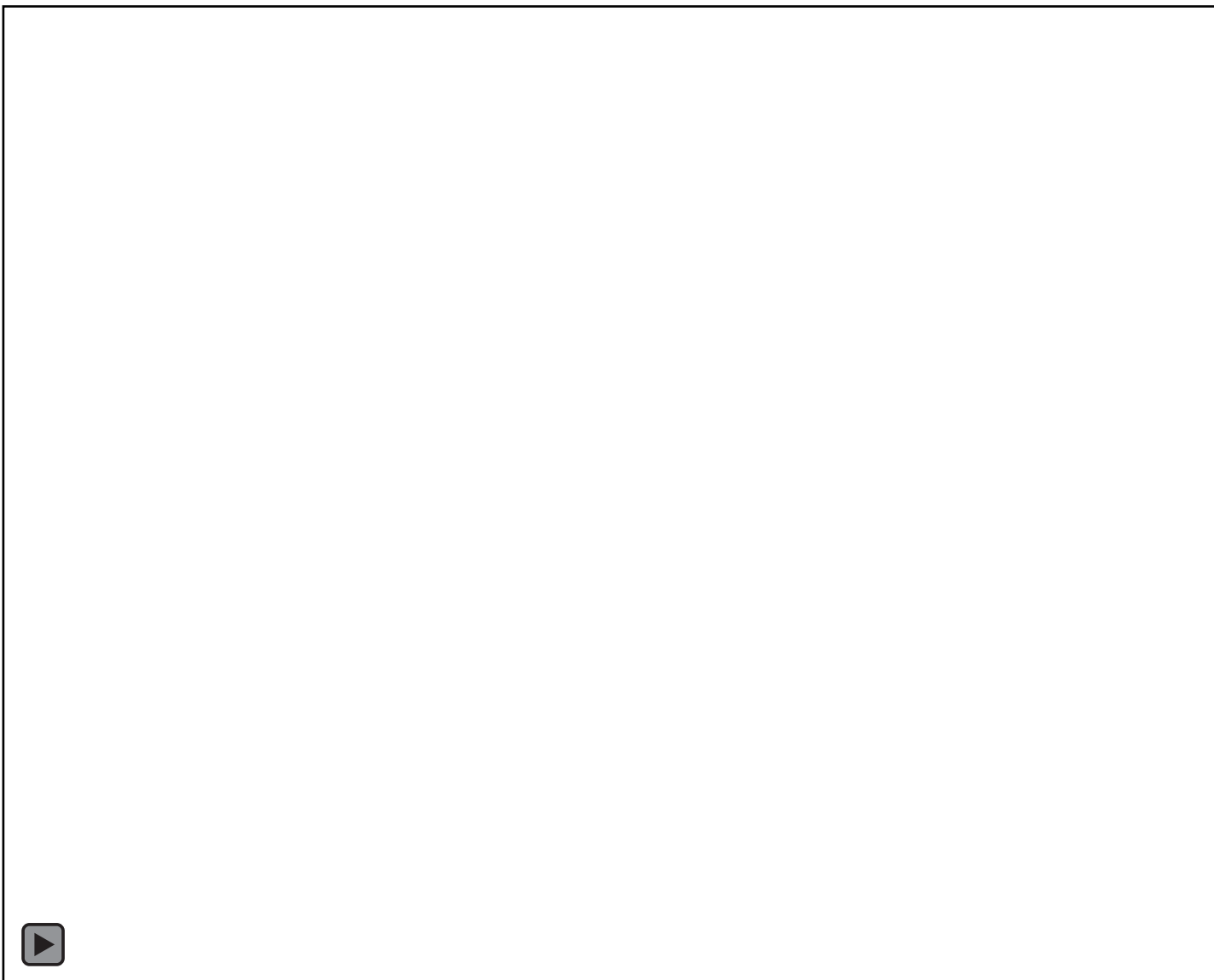
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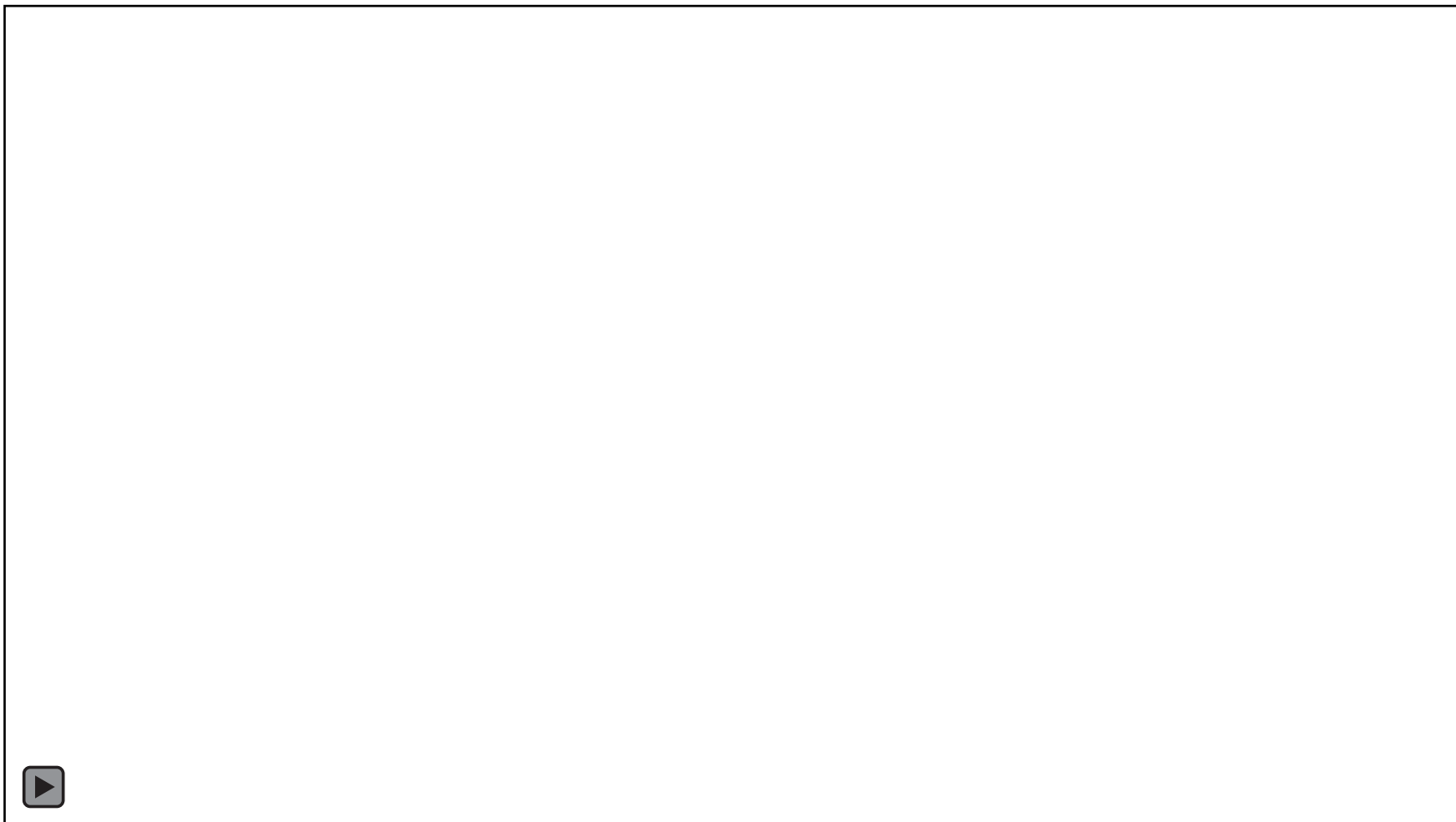
Adv. Mater. **34**, 2110027 (2022).

Optical contrast



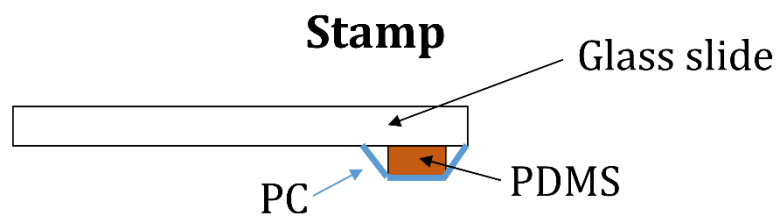
van der Waals heterostructures

★ Dry transfer method ★



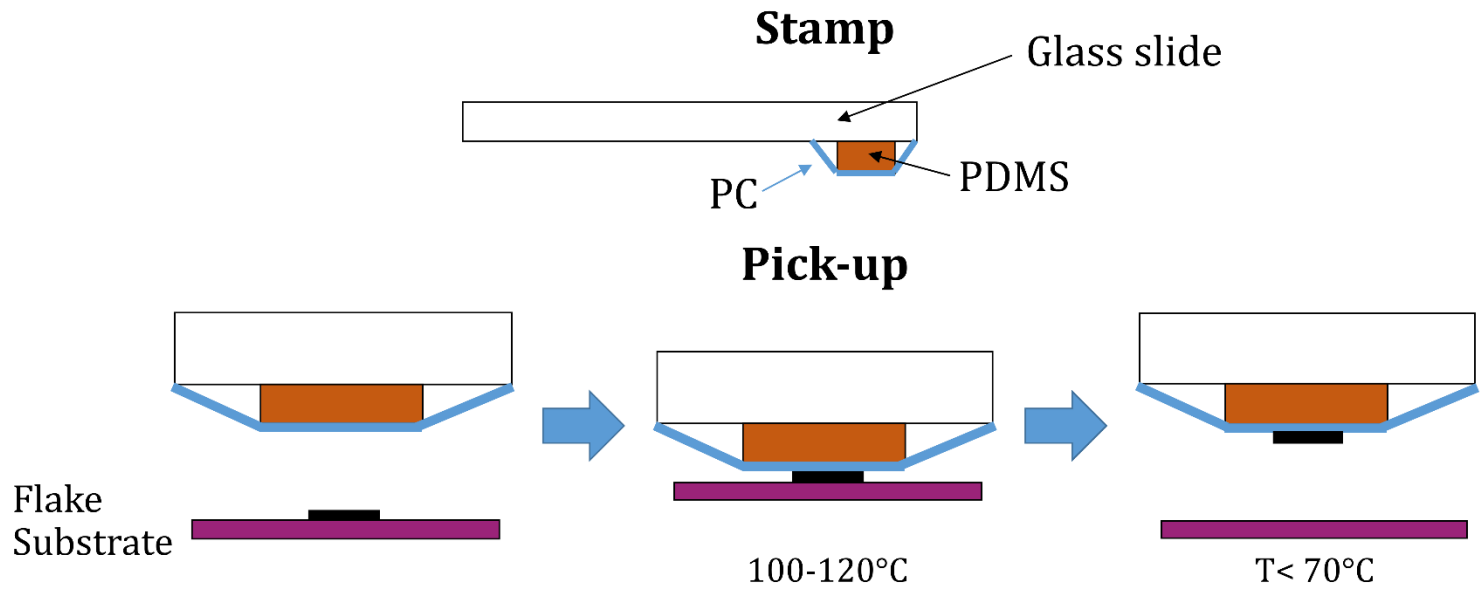
van der Waals heterostructures

★ Dry transfer method ★



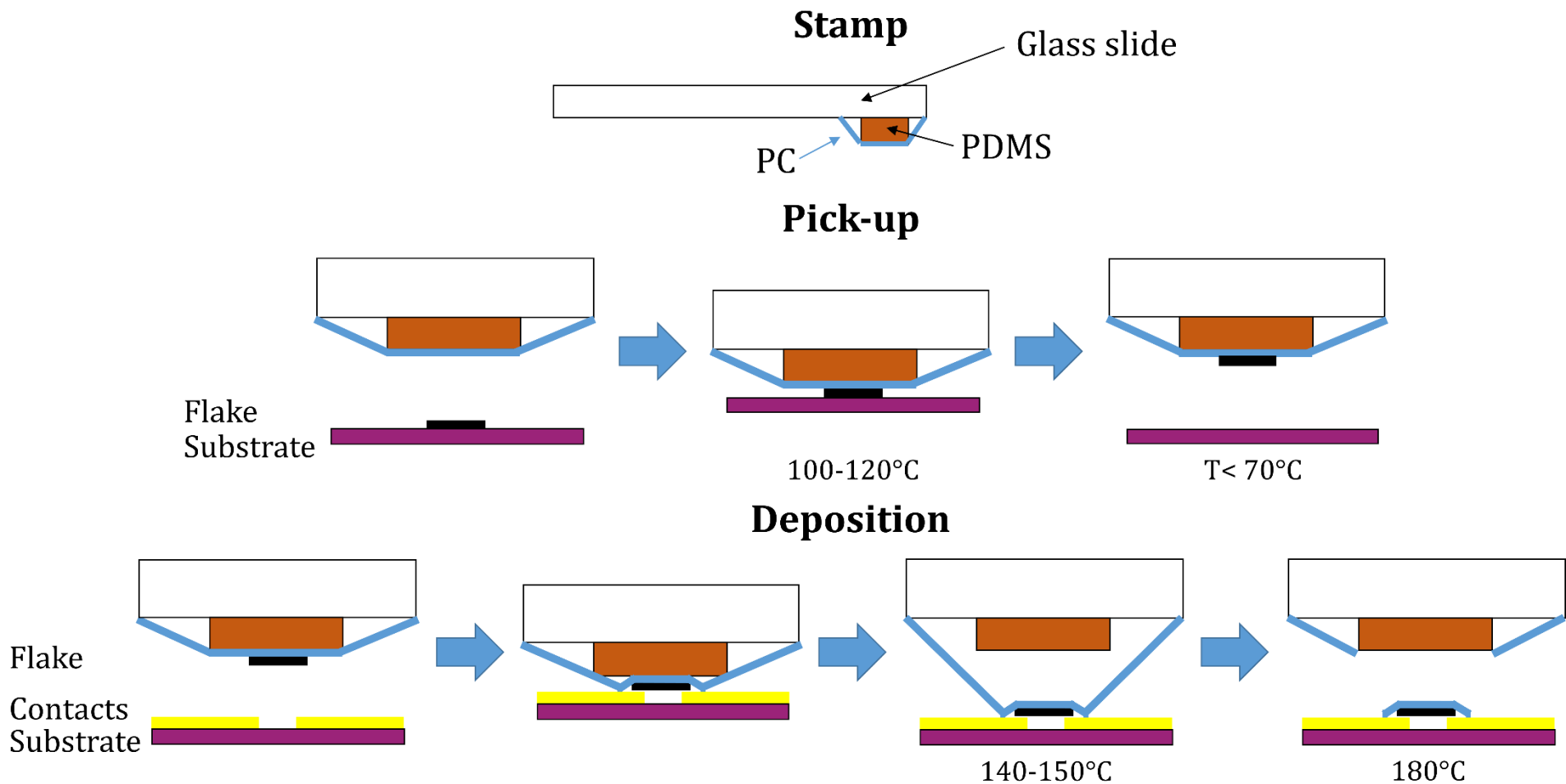
van der Waals heterostructures

★ Dry transfer method ★



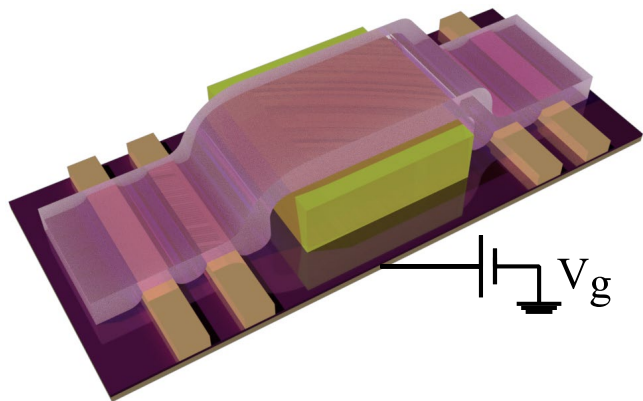
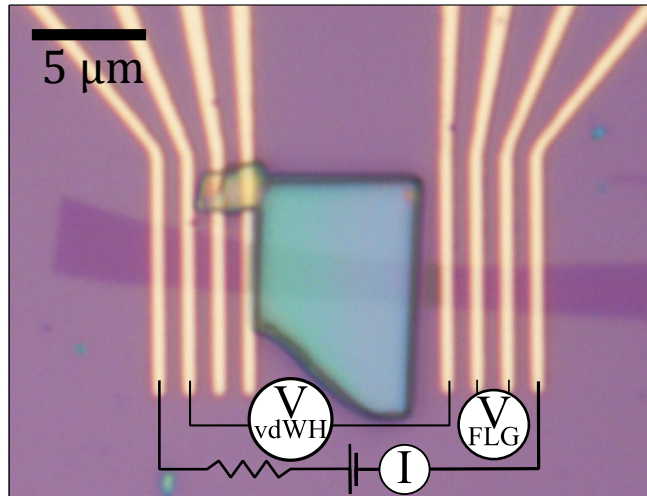
van der Waals heterostructures

★ Dry transfer method ★



Hybrid heterostructures

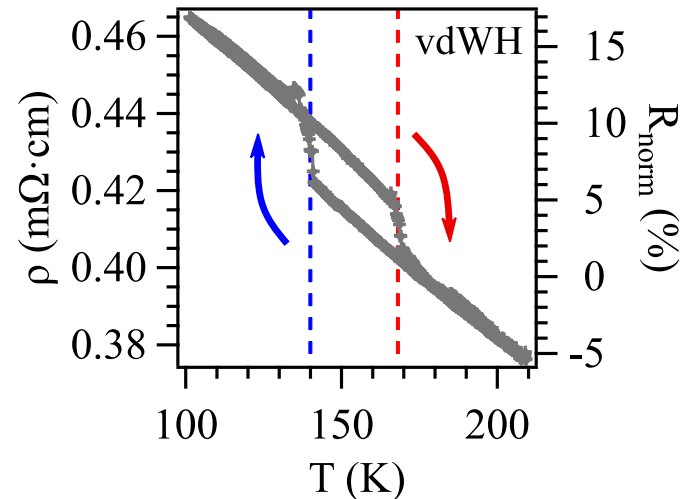
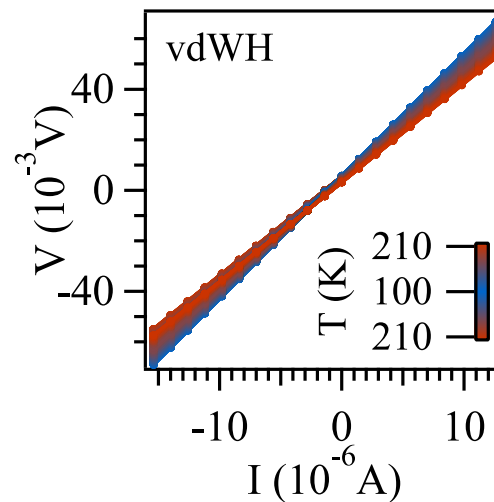
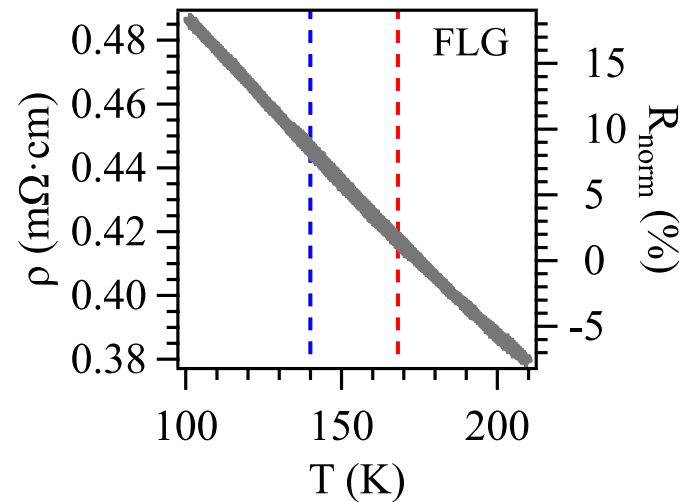
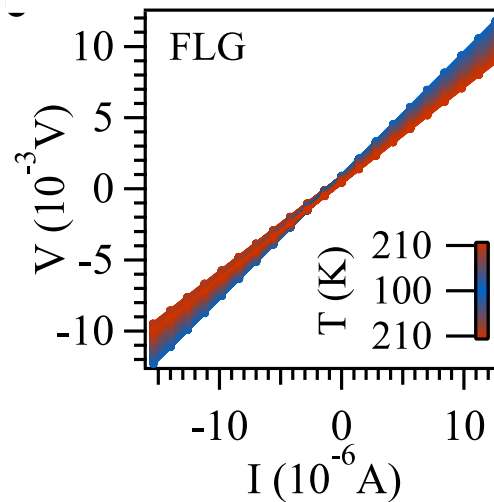
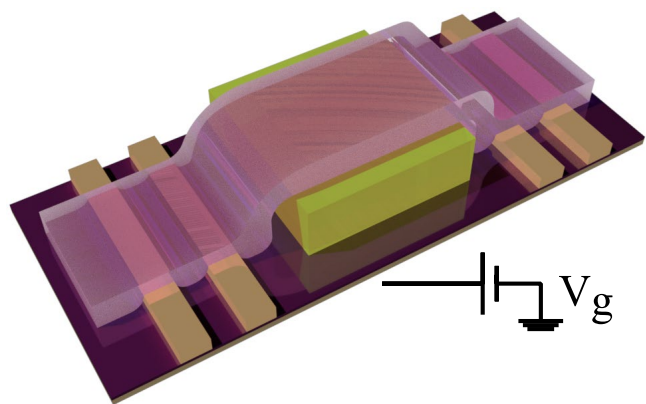
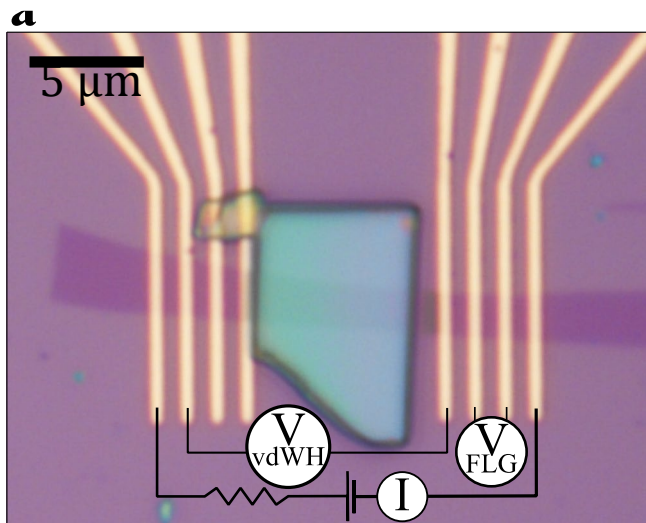
→ **Electronic transport measurements:**



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Hybrid heterostructures

➔ **Electronic transport measurements:**

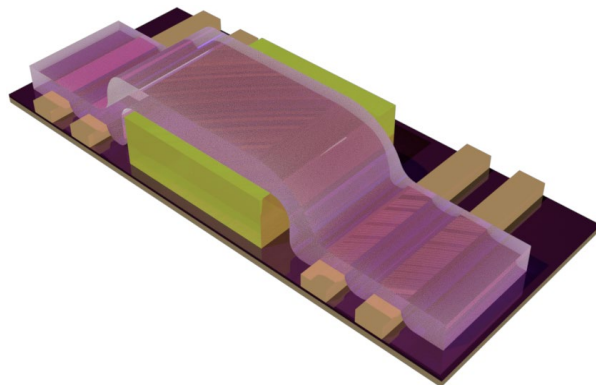


Adv. Mater. 34, 2110027 (2022).

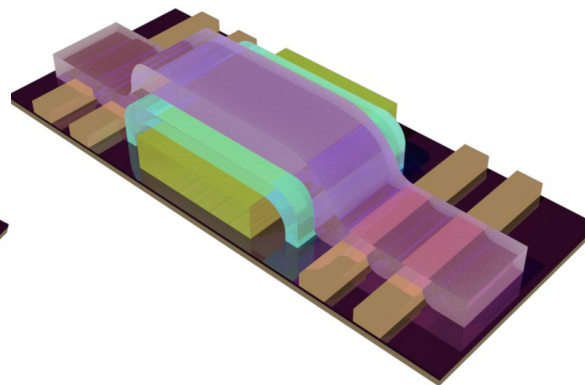
Hybrid heterostructures

★ Different configurations ★

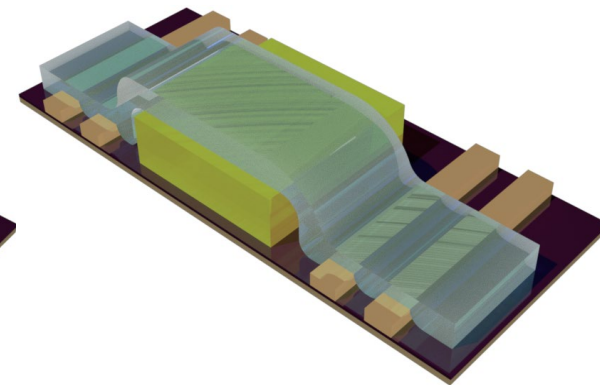
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SCO/FLG



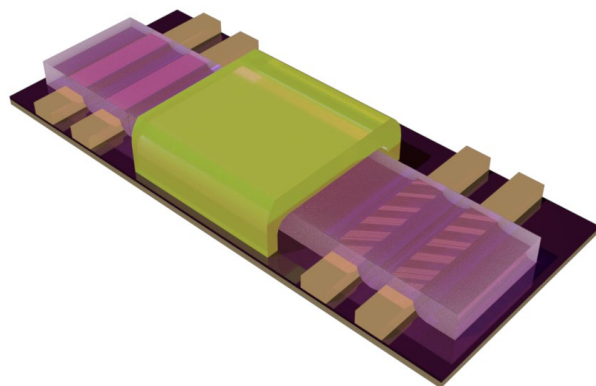
vdWH Type C
SCO/h-BN/FLG



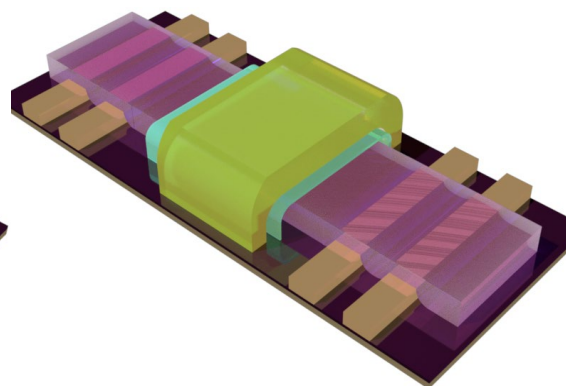
vdWH Type E
SCO/NbSe₂



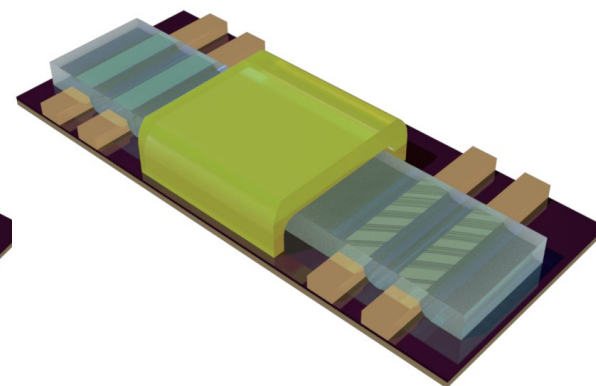
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FLG/SCO



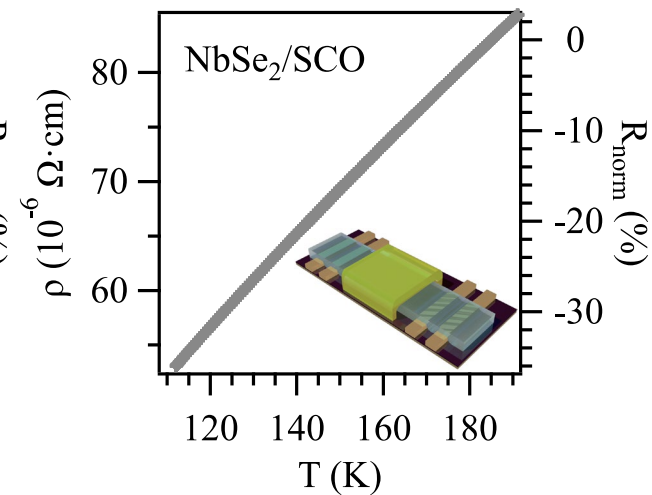
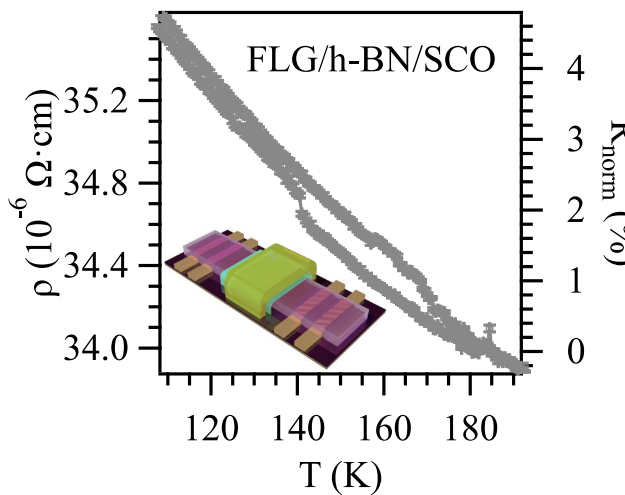
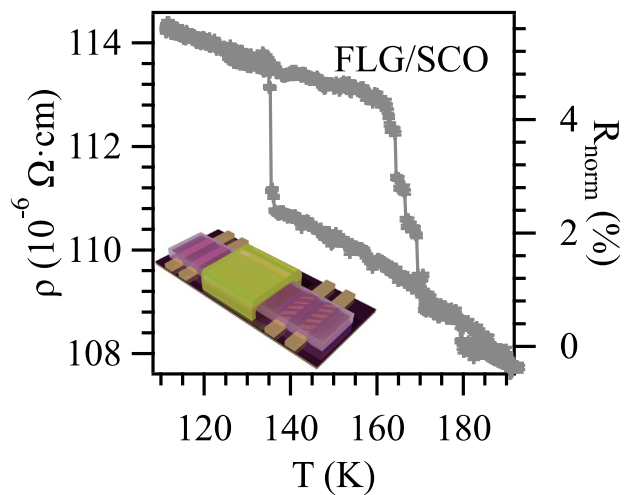
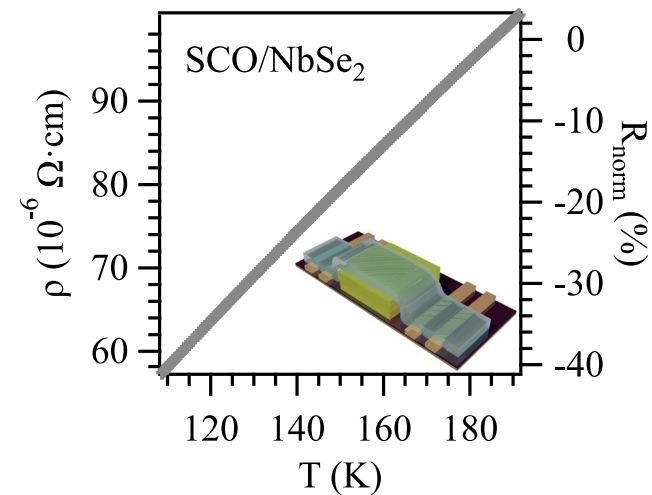
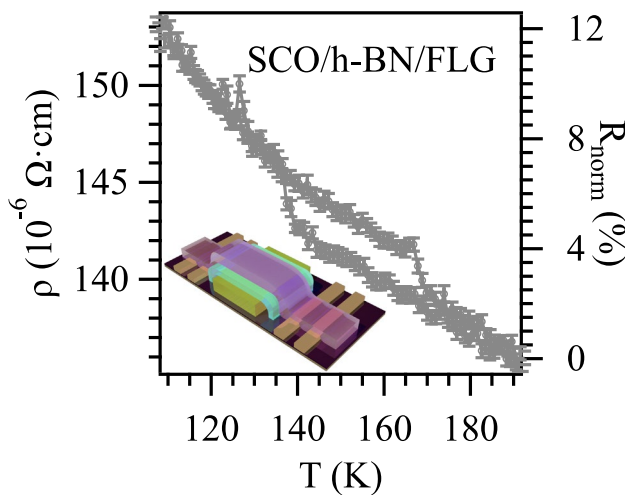
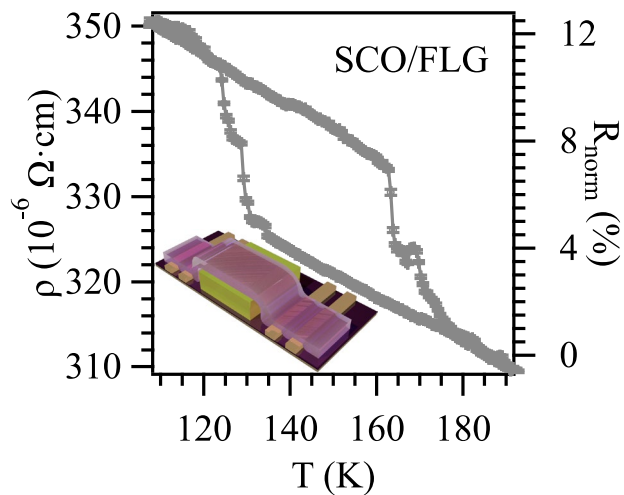
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FLG/h-BN/SCO



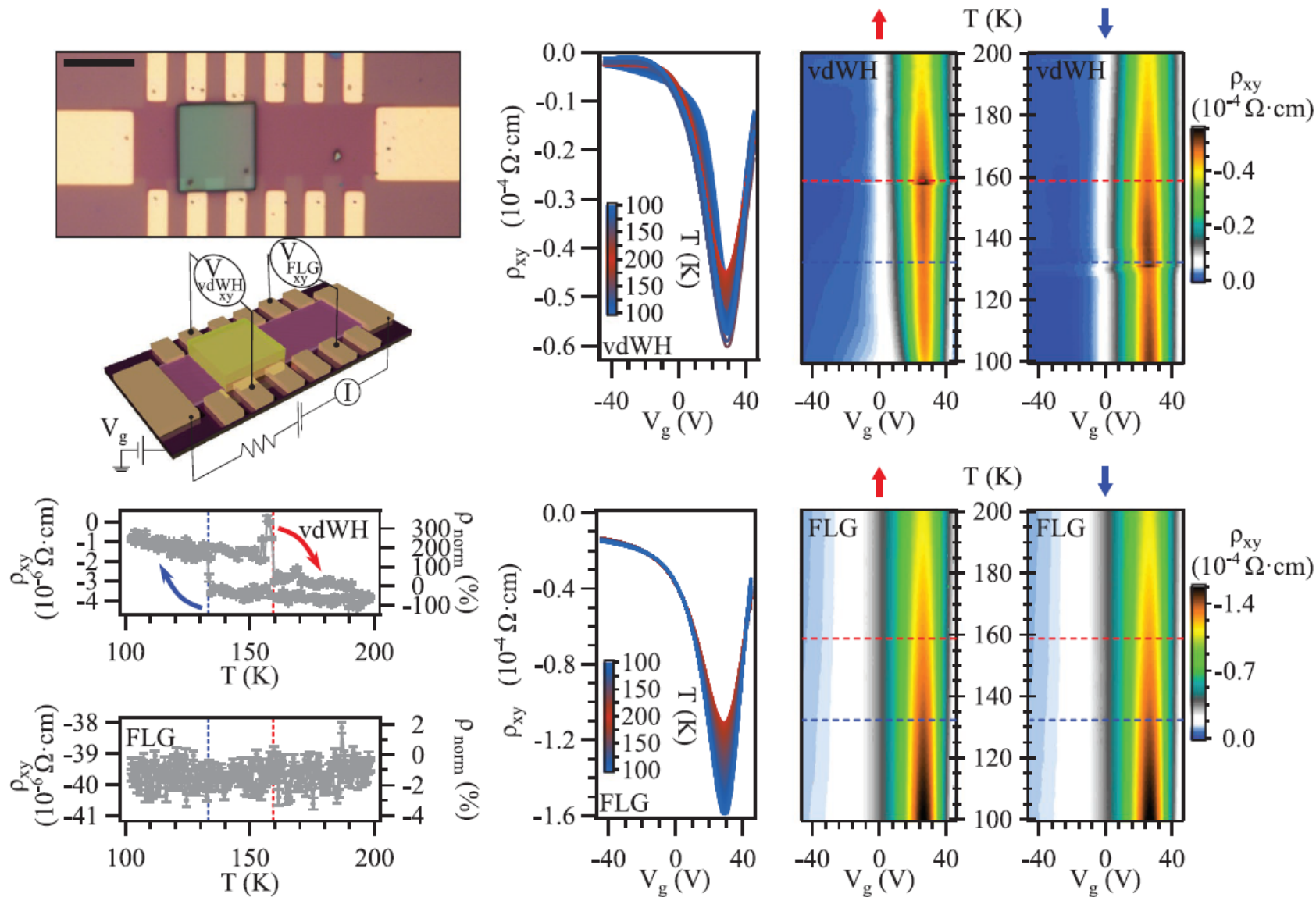
vdWH Type F
NbSe₂/SCO



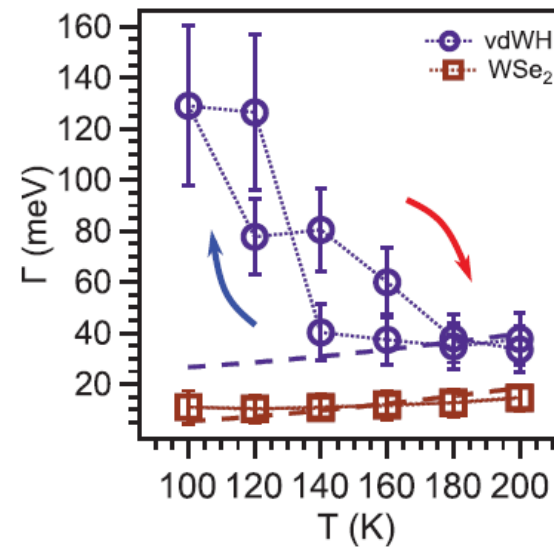
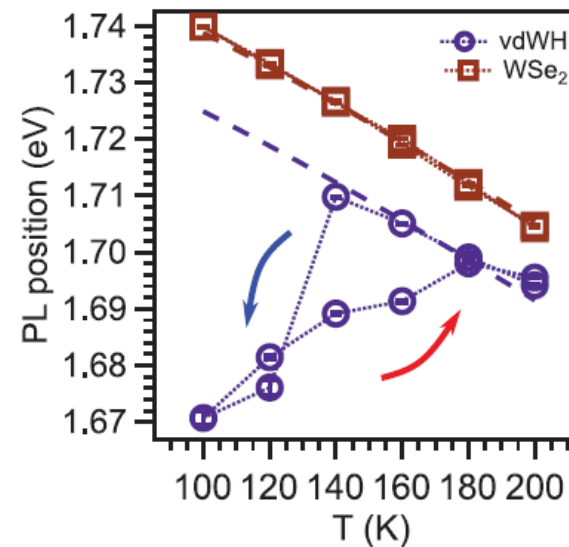
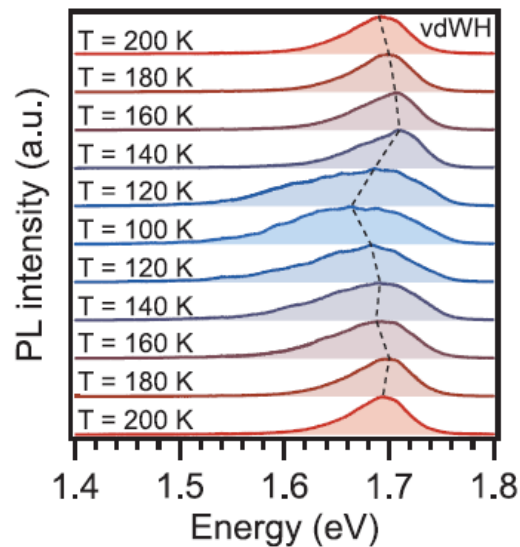
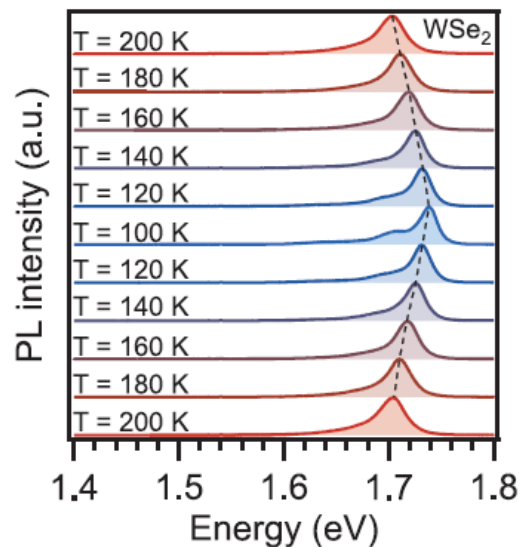
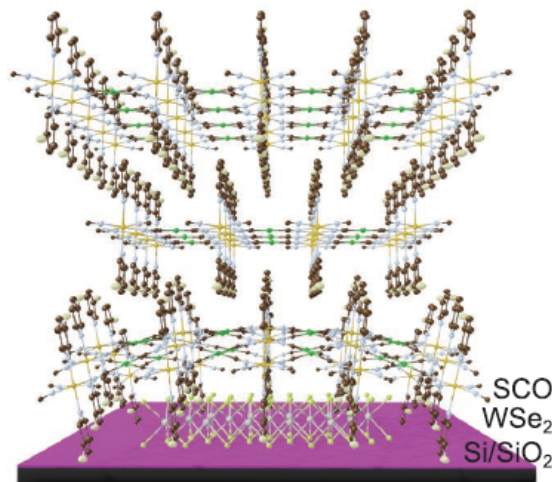
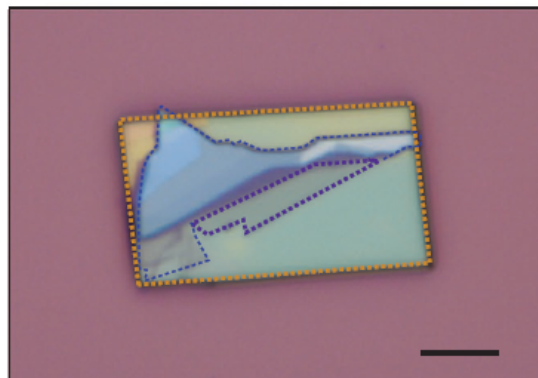
Hybrid heterostructures



Hybrid heterostructures

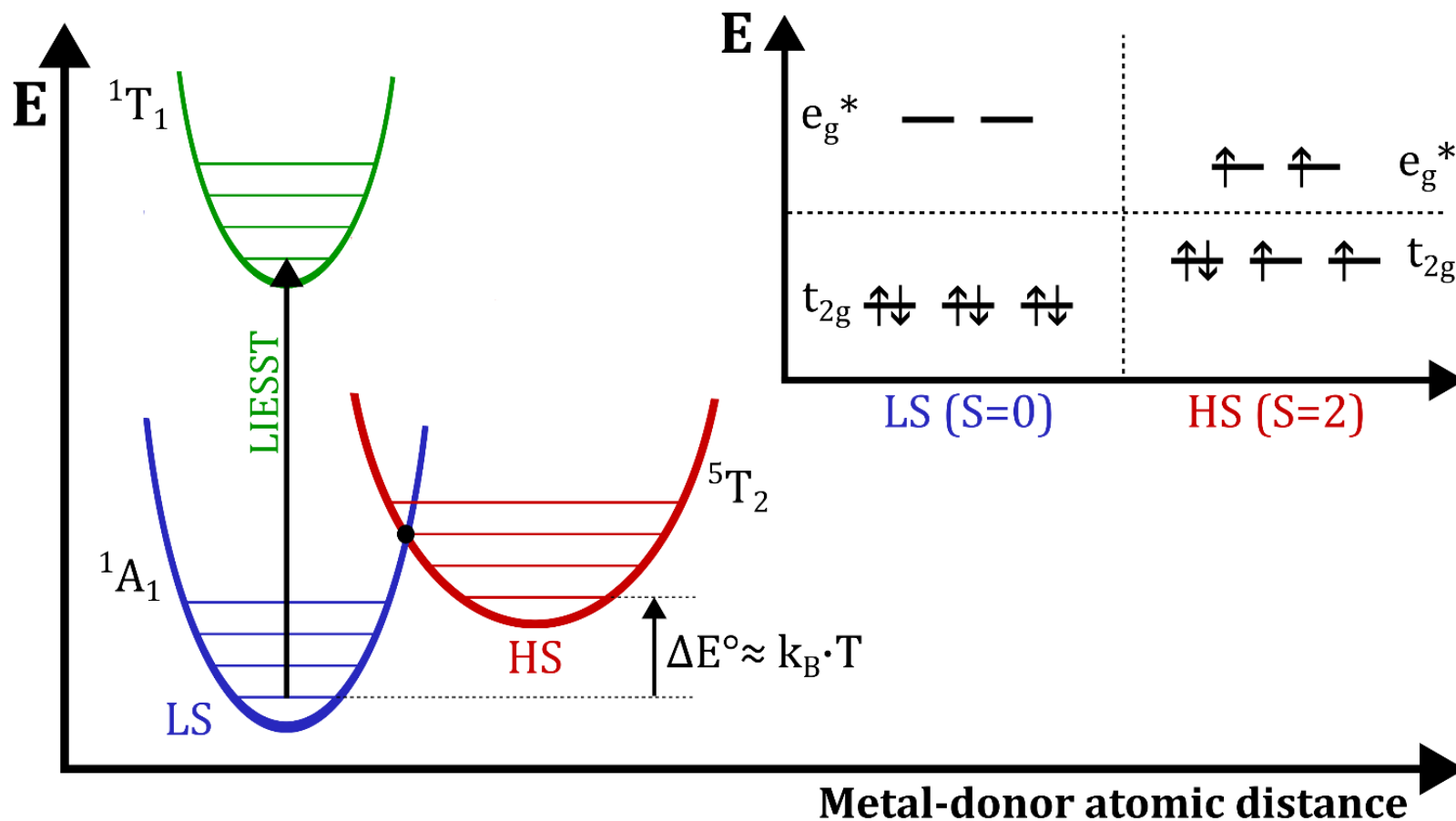


Hybrid heterostructures



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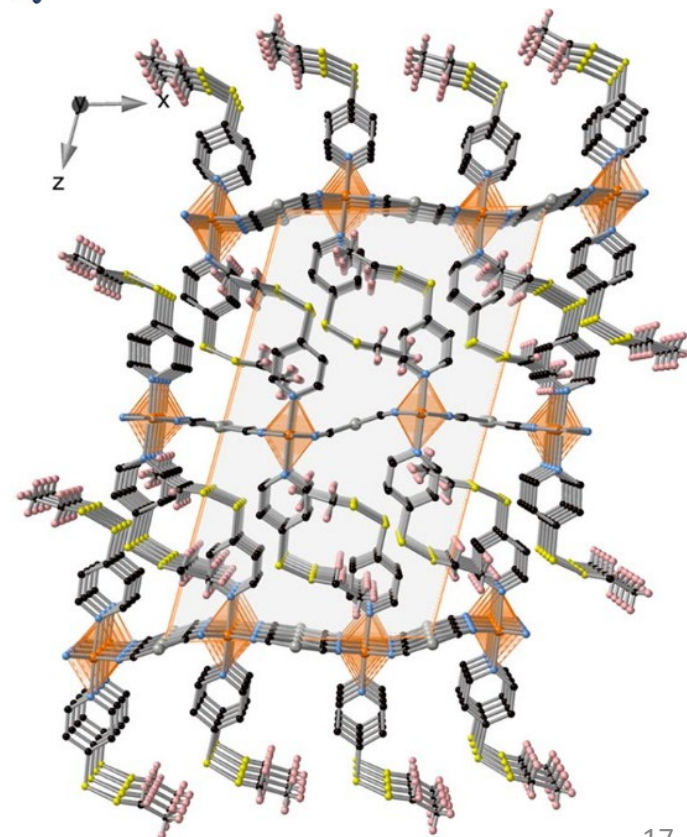
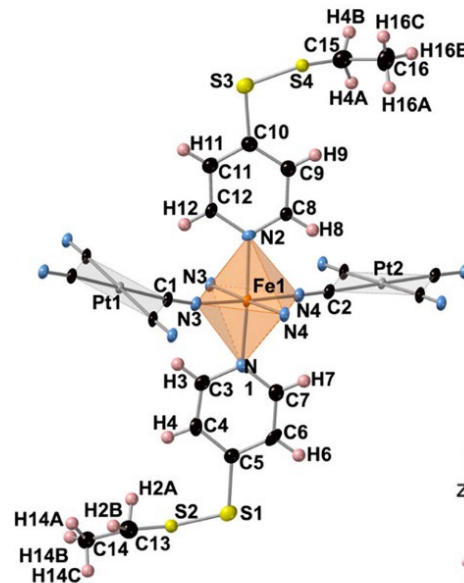
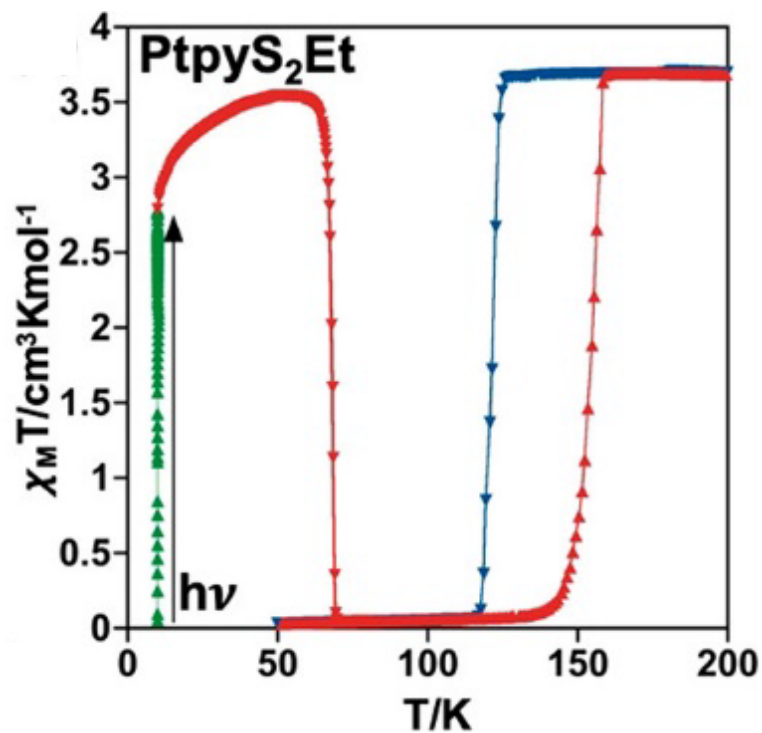
LIESST effect: Light-Induced Excited Spin-State Trapping.



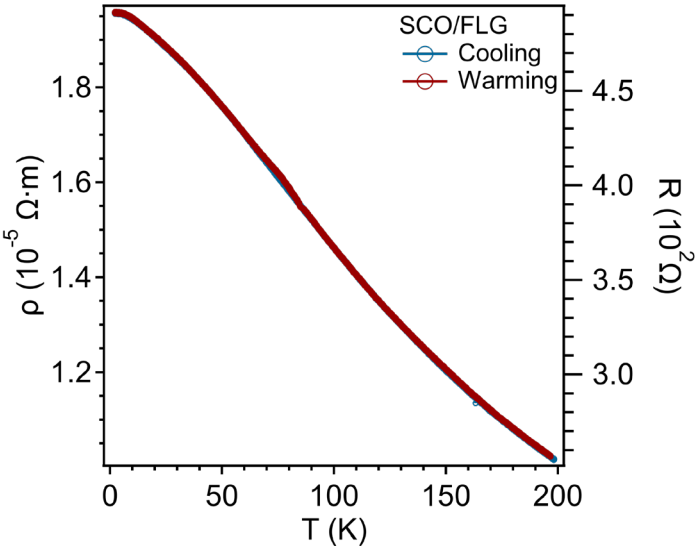
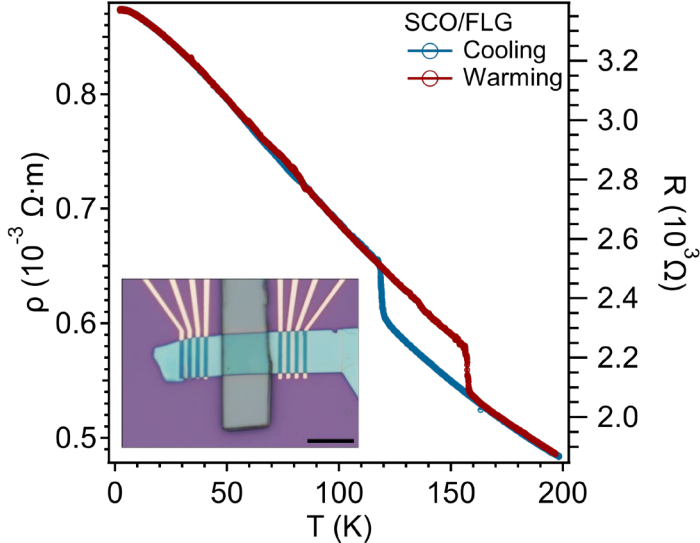
LIESST effect: Light-Induced Excited Spin-State Trapping.

Inorg. Chem. 60, 9040-9049 (2021).

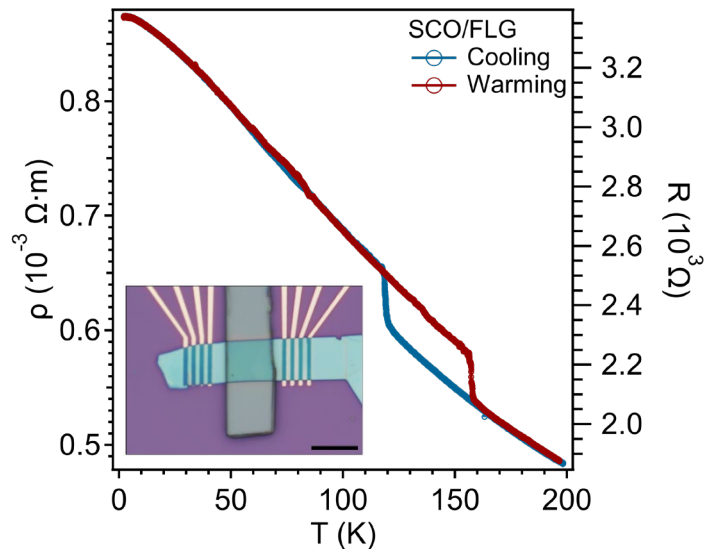
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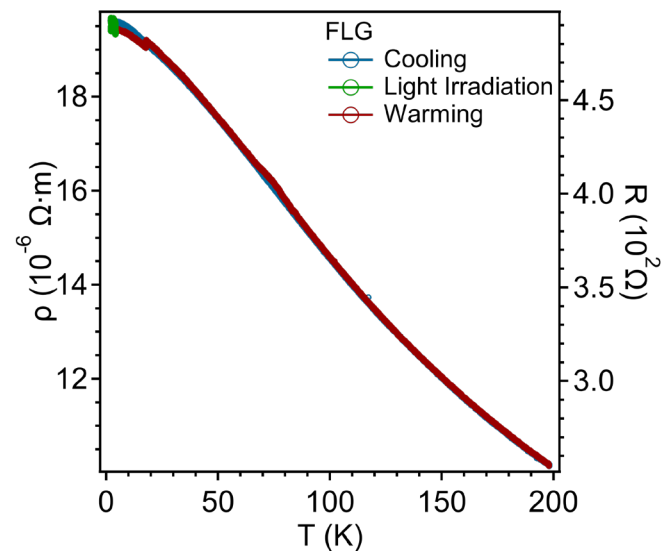
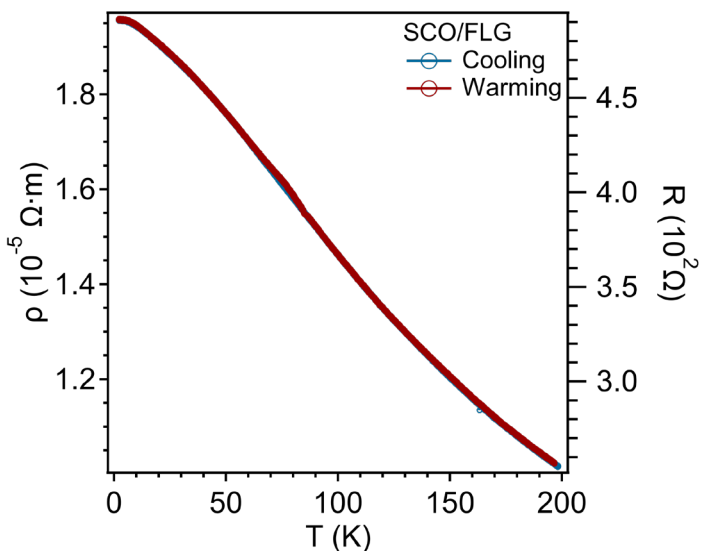
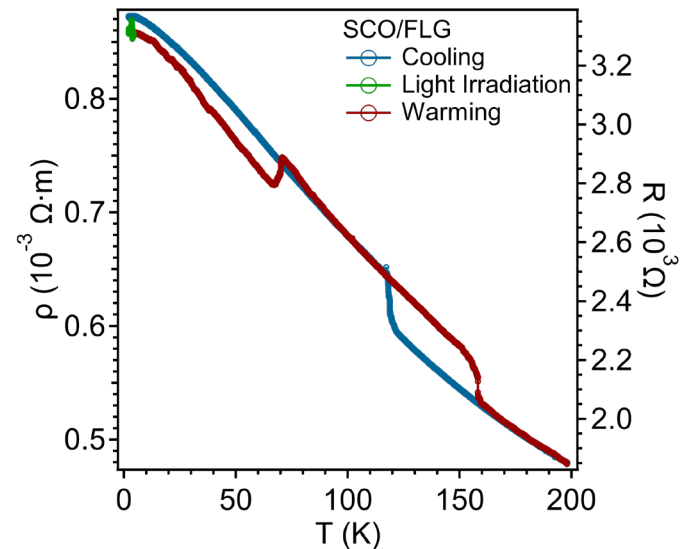
LIESST effect: Light-Induced Excited Spin-State Trapping.

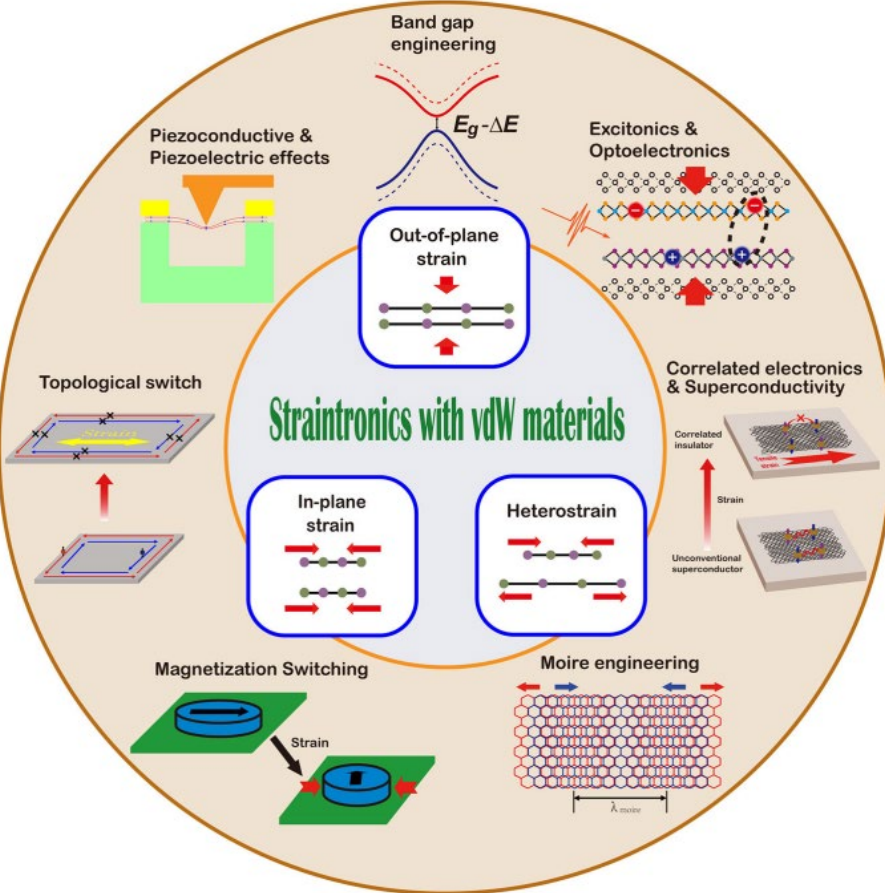


LIESST effect: Light-Induced Excited Spin-State Trapping.



$h\nu = 532 \text{ nm}$

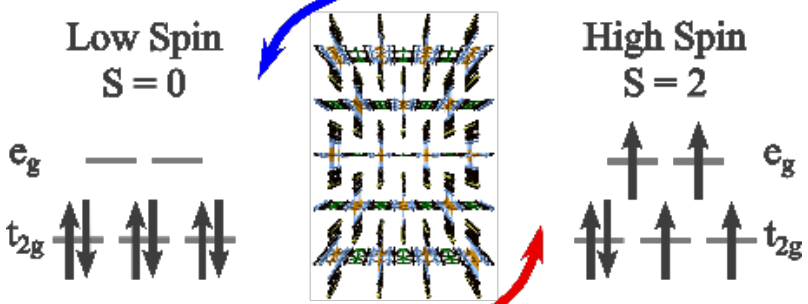




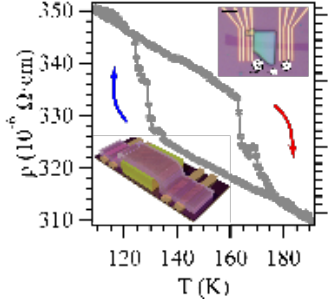
npj Quantum Materials **59** (2021).

Molecular straintronics?

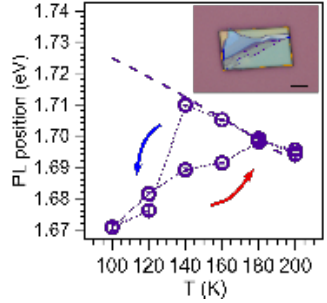
Spin-Crossover van der Waals Heterostructures



Spin-Crossover/Graphene



Spin-Crossover/WSe2



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ICMOL

Prof. Eugenio Coronado
Dr. Samuel Mañas-Valero
V́ctor Garća-Ĺpez
Prof. Miguel Clemente-León
Dr. Efrén Navarro-Moratalla
Ángel López Muñoz

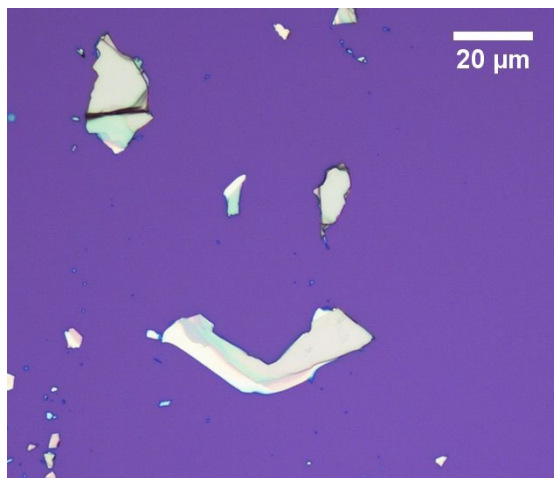


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**THANK YOU FOR YOUR
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