Consiglio Nazionale delle Ricerche - Istituto di Chimica dei Composti Organometallici

Immobilization of Palladium Nanoparticles on Exfoliated Black Phosphorus

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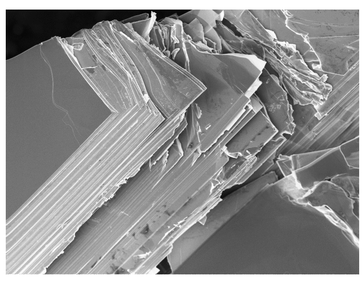
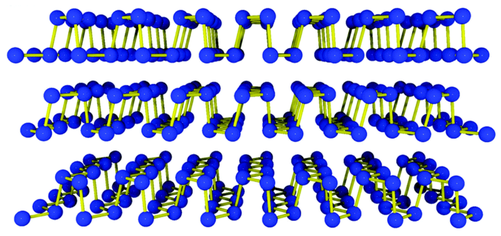
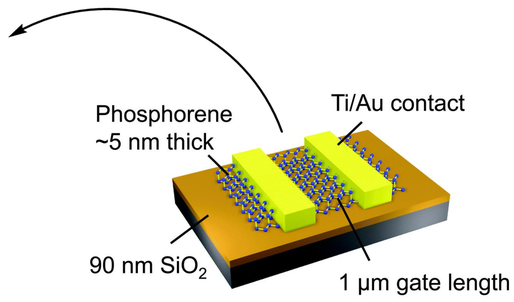
One of the latest member to join the family of 2D materials is few layer black phosphorus. Black phosphorus (bP) is a natural semiconductor which exhibits band gap tunability upon variation of the layer thickness (from 0.3 eV of the bulk BP to 1.8 eV of the monolayer *phosphorene*) and a strong anisotropy in both its electric and mechanical properties along different directions in the layer. A surface made of sp^3 hybridized phosphorus atoms seems excellent as a support to anchor metal nanoparticles. We thus decorated 2D bP with Pd nanoparticles grown *in situ* and tested the resulting nanohybrid Pd/bP in the catalytic reduction of nitroarenes. The effect of 2D bP is a dramatic enhancement of the selectivity.



SEM of black phosphorus

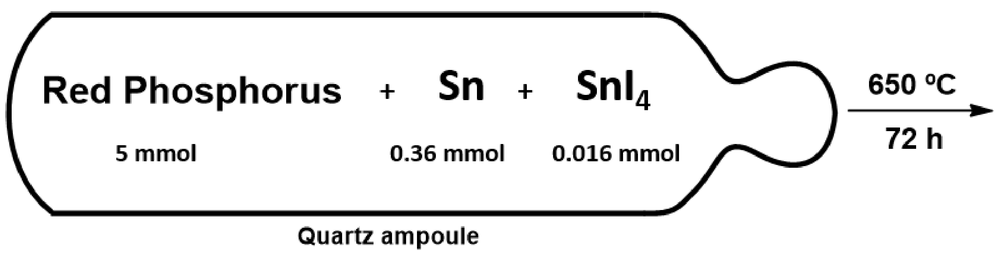


Black phosphorus structure

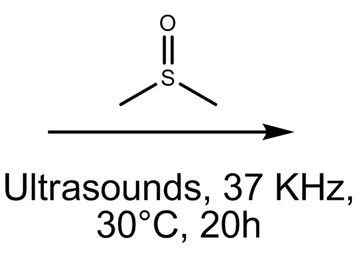


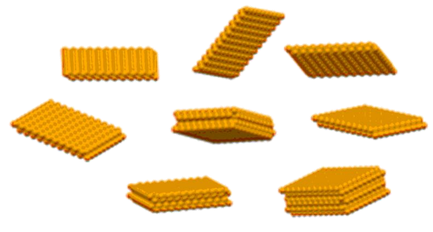
Black phosphorus based FET

Black Phosphorus: Synthesis and Exfoliation



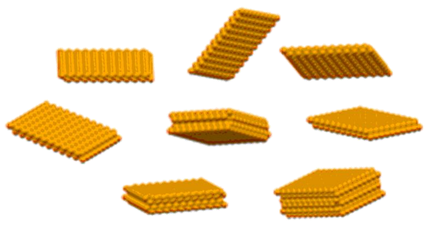
Black phosphorus crystals



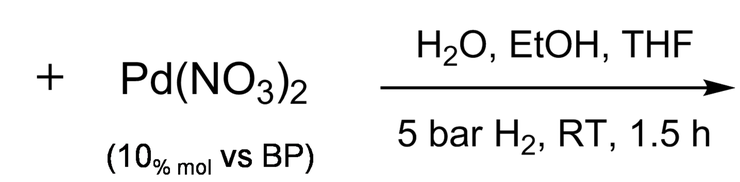


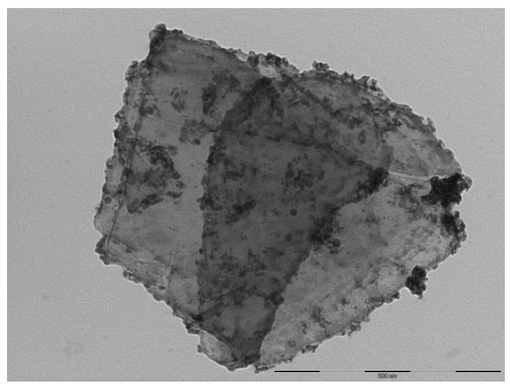
Exfoliated black phosphorus

Palladium Nanoparticles Growth on 2D BP

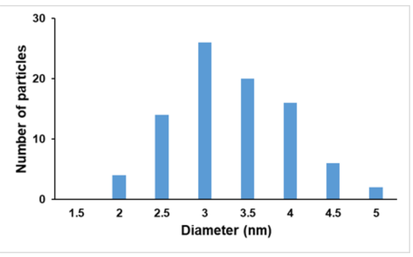


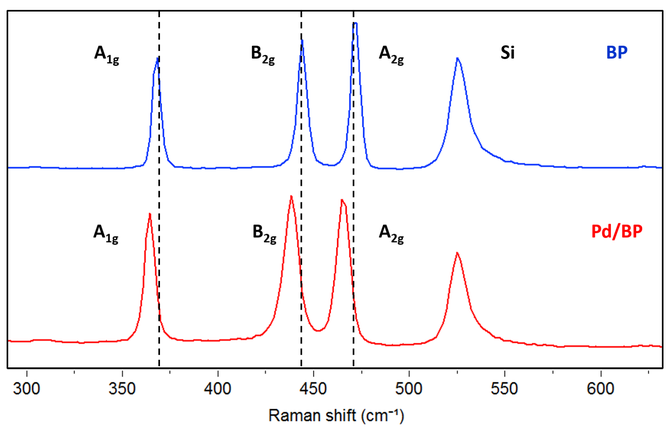
Exfoliated black phosphorus



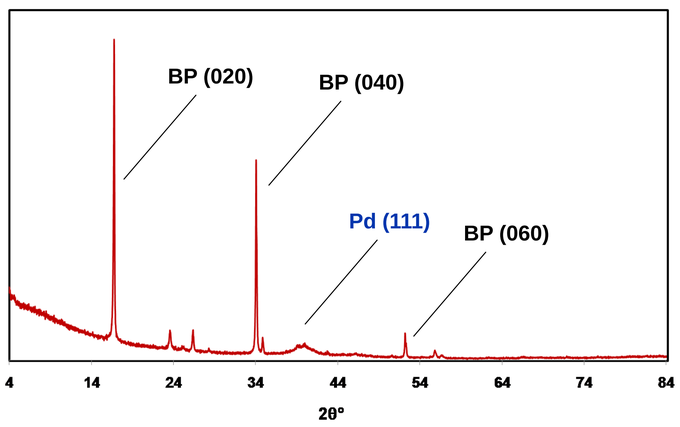


TEM image of Pd NPs on BP

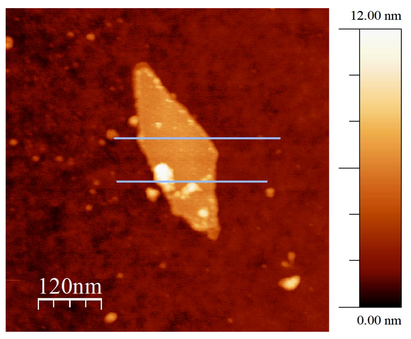


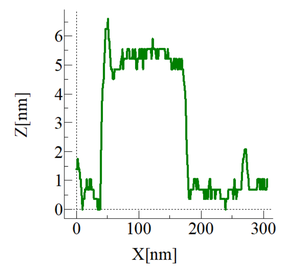


Raman spectra of pristine bP (up) and Pd/bP (down)



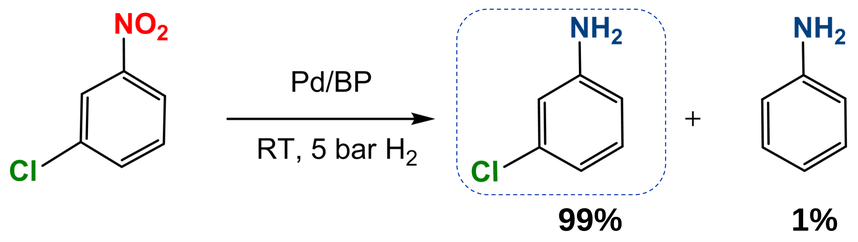
Powder XRD spectrum of Pd/bP





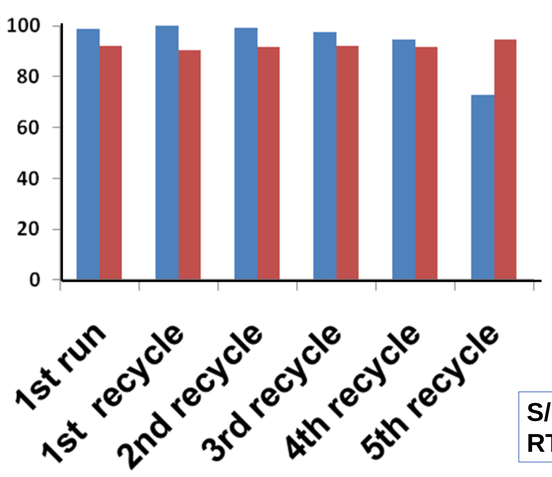
AFM image of a flake

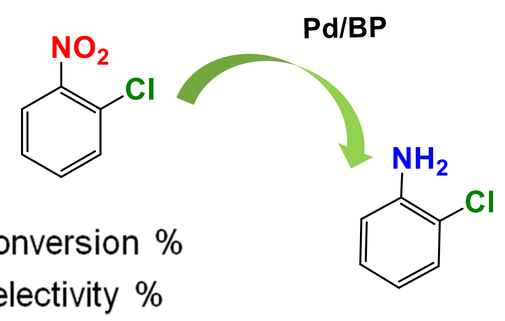
Selective reduction of nitroarenes with Pd/bP



Substrate	Catalyst	S/C	Time (min)	Conversion %	Selectivity %
1-chloro-3-nitrobenzene	**Pd/BP**	110	60	98	**99**
1-chloro-2-nitrobenzene	**Pd/BP**	167	60	100	**95**
1-chloro-2-nitrobenzene	**Pd/ BP *light fraction***	167	40	99	**97**
4-nitrobenzaldehyde	**Pd/BP**	110	90	99	**100**
1-chloro-2-nitrobenzene	**Pd/C**	167	40	86	**72**

o-chloronitrobenzene: recycle test





S/C = 167, solvent = MeOH, [substrate] = 0.242 M, RT, 5 bar H_2, time = 40 min.

Acknowledgements

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