Exfoliated black Phosphorus Surfaces investigated by Scanning Tunneling Microscopy

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We present results on Scanning Tunneling Microscopy (STM) studies of exfoliated black phosphorus (bP). Despite the interest in surface science studies of this layered semiconductor in its few-layer form, there have been few studies up to now due to sample preparation challenges, because of the high reactivity of bP with oxygen and moisture. We developed a protocol to efficiently prepare samples of exfoliated bP for STM experiments, exfoliating bP in an inert atmosphere and using graphene as a flat, conducting substrate. The obtained surface is clean (without resist residues or oxidation traces), and bP flakes can be clearly identified in atomic resolution images, as shown in Fig. 1(a). We studied the surface evolution with temperature, focusing on the regime in which sublimation starts (Fig. 1(b)) and monolayer-deep (Fig. 1(d)) craters, which show a preferential orientation, appear on the surface. Thanks to the atomic resolution provided by STM, we were able to demonstrate that these craters are aligned along the zigzag crystallographic [100] (Fig 1(c)). We are currently studying sub-monolayer coverages of Cu on bP, in order to investigate the growth morphology, and possibly doping effects by Scanning Tunneling Spectroscopy. This study is complemented by density functional theory calculations and simulations of STM images.

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References

[1] Abhishek Kumar, F. Telesio et al, *STM Study of Exfoliated Few Layer Black Phosphorus Annealed in Ultrahigh Vacuum*, 2D Materials, in press, (2018). https://doi.org/10.1088/2053-1583/aadd20

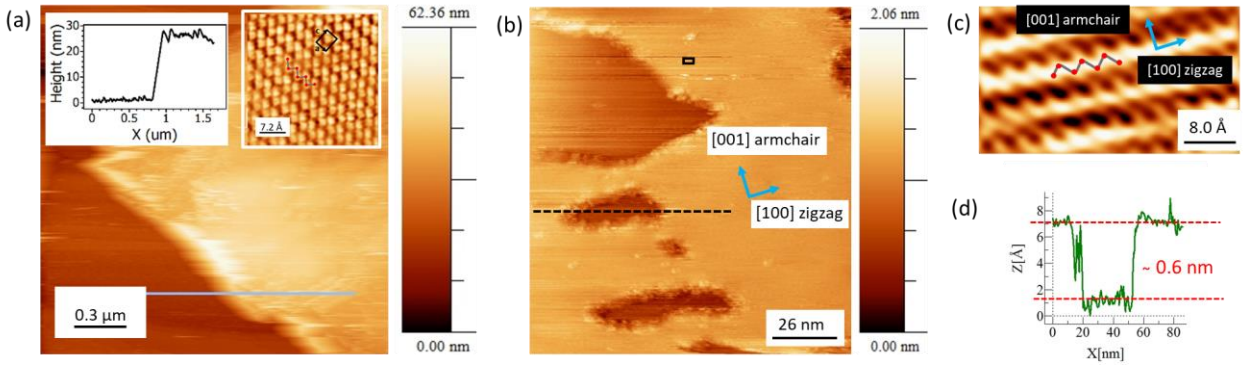

Fig. 1: (a) bP flake on graphene; insets: left: cross section providing thickness, and right: atomic resolution image of bP. (b) bP surface after annealing at 400°C for 2h. (c) Atomic resolution image of the region marked by the black box in (b), and (d) line profile along the black dashed line in (b).

Tipo presentazione (sceglierne uno): orale ~~/ poster~~

Area progettuale di riferimento (sceglierne una): SURF

SSQT Solid-state quantum technology.

FTBIO Fundamental and translational nanobiophysics.

THEO Nanoscale theory modelling and computation.

PHOTO Physics and technology of light at the nanoscale.

SURF Surfaces and interfaces: nanofabrication, imaging, and spectroscopy.