New promising pyrolytic graphite for micro-mechanical exfoliation of graphene

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The highly oriented pyrolytic graphite (HOPG) was traditionally used as a monochromator in neutron and x-ray studies, for thermal management and other applications. Currently, HOPG is increasingly utilized in nanotechnology applications. HOPG is used as a substrate in scanning probe microscopy, since its surface contains large atomically smooth areas. Laboratory samples of graphene are produced by micro-mechanical cleavage of HOPG. In this work, a new pyrolytic graphite called HAPG [1], specially adjust for high resolution spectroscopy and nanotechnology applications, was investigated. The technology of the graphite production was optimized so that the graphite structure and the number of defects were most similar to natural graphite crystals.

HAPG and HOPG samples with the mosaic spread of 0.4^o and 0.8^o were studied by atomic-force microscopy (AFM). The surface of graphite may contain a variety of defects after cleavage [2]. The most common defects are the cleavage steps and edge dislocations with the Burgers vector perpendicular to the basal plane of graphite. In the AFM images the edge dislocations are observed as the steps with a curved shape. The average length of the cleavage steps per unit area was 1.3 μm^{-1} for HOPG. HAPG has the average length of the steps of 0.25 μm^{-1}. The defects are almost absent in many AFM images with the area of more than 100 μm^2 (Figure 1). The edge dislocations and grain boundaries were observed less frequently on the surface of HAPG in comparison with HOPG. In general, the surface quality of HAPG is similar to the surface quality of mica, which is widely used in scanning probe microscopy.

Graphene samples were obtained by the micro-mechanical cleavage of HOPG and HAPG. Silicon oxide, deposited on the polycrystalline silicon, was used as a substrate. The thickness of the silicon oxide was about 300 nm. An optical image of a graphene layer, produced by HAPG cleavage, is shown in Figure 2.

The graphene samples were studied with the help of micro Raman spectroscopy. It was found that the number of graphene layers depended significantly on the graphene preparation procedure. It should be noted that the graphene layers, produced by HAPG cleavage, were thinner and contained less defects. This paper shows that HAPG is a very perspective material for nanotechnology applications.

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References

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Figures

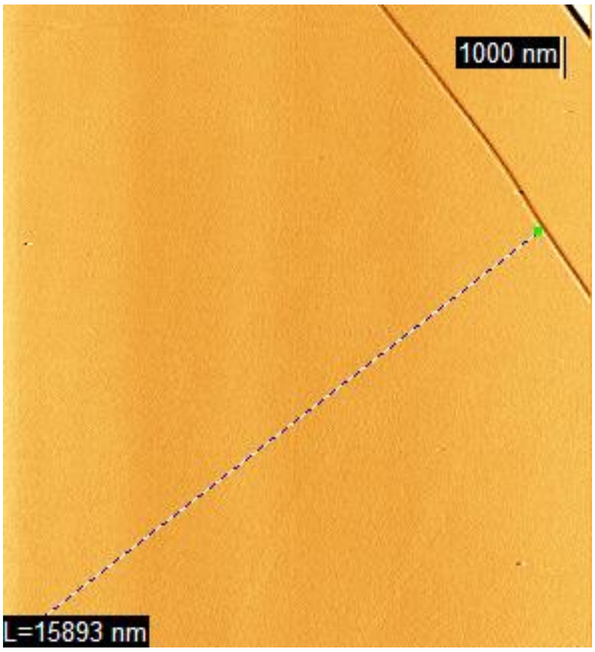

Figure 1. The surface of HAPG after cleavage. AFM image.

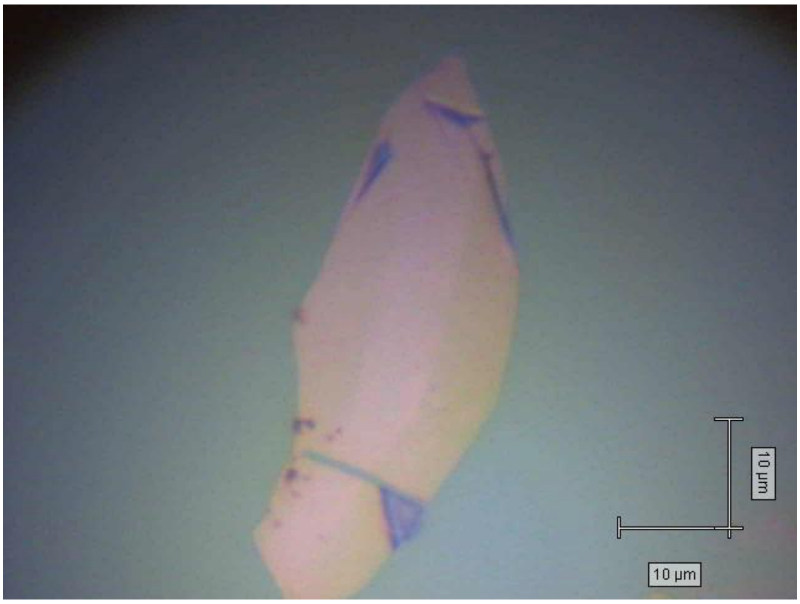

Figure 2. A graphene, prepared by HAPG cleavage. Optical image.