

## General Description of HOPG

Highly Oriented Pyrolytic Graphite (HOPG) and Thermoconductive Pyrolytic Graphite (TCPG) are forms of high purity Pyrolytic Graphite annealed under pressure and high temperatures and refers to graphite with an angular spread between the graphite sheets of less than  $1^\circ$

HOPG terminated with graphene layer is an excellent tool for using in scanning probe microscopy as a substrate or calibration standard at atomic levels of resolution. This is an easily renewable material with an extremely smooth surface, cleaves almost like mica.

The usual approach to cleave HOPG is to take a piece of tape, press it onto the flat surface, pull it off and the tape invariably takes with it a thin layer of HOPG. This freshly cleaved surface is what is used as sample substrate material. It has an ideal atomically flat surface and provides a background with only carbon in the elemental signature thus making results in a featureless background. This is vital for SPM measurements that require uniform, flat, and clean substrates, for samples where elemental analysis is to be done.

HOPG specimens are layered polycrystals, similar to mica. Each bulk polycrystal looks like mosaic of microscopic monocrystal grains of different sizes. The structure is columnar, the columns run vertically within the flat slab of the material, and the grain boundaries can be seen on the lateral surfaces. The grains are slightly disoriented with respect to each other. The surface of specimen consists of many randomly placed steps – result of the cleaving process: single atomic steps and steps of several or dozens of atomic layers. Although the heights of multilayer hills and valleys are not calibrated, single steps have the well-defined height of 0.34 nm and can be used for calibration in z direction. To characterize the angle of deviation of the grain's boundaries from the perpendicular axis of the columnar structure, a measure of the parallelism of grains – perfectness of HOPG samples, a "mosaic spread" term is used. The lower the mosaic spread, the more highly ordered the HOPG.

NanoAndMore provide HOPG substrate in three different quality grades. Our HOPG substrates are cleavable from **both** sides. Substrates are available in different thickness.

### GRADE ZYA

Mosaic spread angle is  $0.4^\circ \pm 0.1^\circ$ . The highest quality HOPG, ZYA is intended for instrument calibration. Virtually no steps are seen on the cleaved faces.

### GRADE ZYB

Mosaic spread is  $0.8^\circ \pm 0.2^\circ$ . Suitable for most research applications, when samples are to be mounted for analysis.

### GRADE ZYH

Mosaic angle is  $3.5^\circ \pm 1.5^\circ$ . Ideal for non-critical work. The perfect low-cost alternative to the classroom environment and student use.