Transient charging phenomena in graphite

Zagaynova V.*[1], Hacke C.[1], Chowdhury T.[1], Makarova T.[1,2]

[1]*Umeå University, 90187, Umeå, Sweden*
[2]*Ioffe Physical-Technical Institute RAS, 194021, St.Petersburg, Russia*
**e-mail: valeria.zagainova@physics.umu.se*

In carbon research, as well as in general research, graphite being the most stable carbon allotrope is one of the most studied materials. In scanning probe microscopy, graphite is used as calibration grates and atomic-smooth hydrophobic substrates. Surprisingly, very few studies are made on electrostatic force microscopy. Here, we demonstrate the ability of this technique to detect hidden defects (buried underneath) and follow the spatial charge redistribution under the action of electric field.

Graphite is a good electric conductor along its planes, and an insulator only perpendicular to the planes. Therefore, the electric field applied to the plane should not cause any potential fluctuations. And yet, they exist.

Under applied voltage, dendriform quickly changing charged areas were formed limited in their spatial expansion by the surface steps (see Fig. 1). Changing the tip polarity inverted the dark/bright images (Fig. 1 b and c). The charging phenomena were observed only in the pyrolytic graphite samples with the lowest mosaic spread, i. e. highest quality.

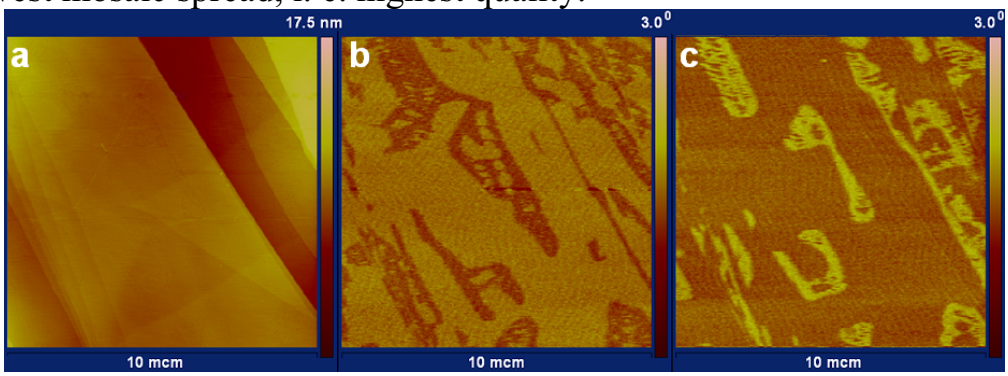

Figure 1. EFM images of HOPG graphite: a – topography, b, c – phase images taken at +2V and -2V, respectively.

The measurements performed in nitrogen atmosphere proved that observed fluctuations do not belong to effects caused by surface contamination such as adsorbed water. Besides, ideal graphite screens poorly, and applied electric field penetrates ~100 nm. Thus, the potential information comes not only from the surface, but charges within the bulk might group themselves at or close to surface steps or buried plane edges and also contribute to the signal.

Further studies on the charging phenomenon of HOPG graphite are needed to understand the origin of this effect.