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Making and characterizing nanostructures on HOPG

M. M. Lucchese[(1,2)*], S. B. Peripolli[(2)], C. A. Achete[(2,3)] and A. Jorio[(2,4)]

(1) Centro de Ciências Exatas e Tecnológicas, Universidade Federal do Pampa, Bagé, Rio Grande do Sul, Brazil, *mmlucchese@gmail.com
(2) Divisão de Metrologia de Materiais, Instituto Nacional de Metrologia Normalização e Qualidade Industrial, Xerém, Duque de Caxias, Rio de Janeiro, Brazil.
(3) Programa de Engenharia Metalúrgica e de Materiais, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Rio de Janeiro, Brazil.
(4) Departamento de Física, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil.

Abstract – We produced ordered nanostructures on a HOPG (highly ordered pyrolytic graphite) arranged in a given pattern with a focused ion beam (FIB) irradiation, figure 1 (a) and studied the graphite sample by Raman spectroscopy. Beyond nanostructures produced in graphite, we observed damage induced by radiation of electron beam. We made a thermal treatment to restore the damages.

With the ion beam we can produce different nanostructures in graphite. But the radiation can damage the graphite and induce undesirable defects [1]. In this work we produced ordered nanostructures in a HOPG (highly ordered pyrolytic graphite) arranged in a given pattern with a focused ion beam (FIB) irradiation, as shows as in figure 1 (a) and studied the graphite sample by Raman spectroscopy, as shown in figure 2. The FIB irradiation was carried out using a Nova nanolab Dual beam platform. The SEM image (fig. 1) shows a square pattern collected after the graphite bombardment made by Nova nanolab using a focused ion beam at 30 kV and 10 pA current.

The Raman spectroscopy (fig.2) shows the HOPG sample, before e-beam incidence on graphite. This is a typical spectrum of one graphite sample without defects or damages [2]. The blue spectrum (SQUARE) is the graphite sample after the nanostructures fabrication, where we observed damages in the structure. In order to recover the graphite structure, removing the disordered carbon, we made a thermal treatment in air at 450°C and 600°C. The thermal treatment and the air reaction with the carbon located on the borders of the graphite structures (generating CO and CO_2) [3] cleaning the surface.

Raman spectroscopy shows that the structure of graphite was recovered after the thermal treatment, as we can observe from the red line at figure 2 (THERMAL TREATMENT), however, scanning electron microscopy images, figure 1 (b) and (c), show that the surface graphite remains damaged. These results lead us to conclude that the Raman spectroscopy measured deeper graphite layers while SEM shows the details of the surface.

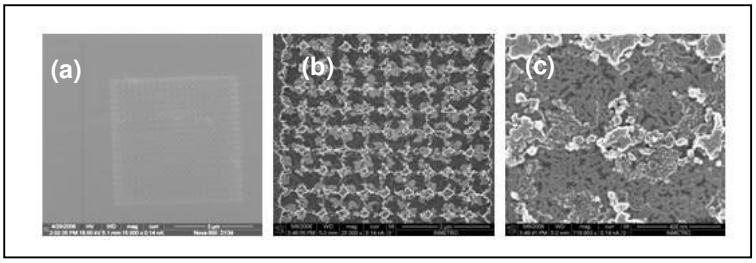

Figure 1: Square structure in graphite made with FIB. (a) The graphene structure, (b) and (c) the same structure after the thermal treatment.

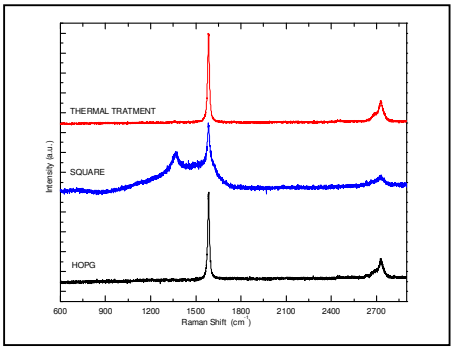

Figure 2: Raman spectroscopy of HOPG without structrure. SQUARE after structure, and THERMAL STRUCTURE after thermal treatment.

References

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