Transmission electron microscopy of Bismuth Telluride

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Bismuth Telluride is a very well known thermoelectric material [1, 2], with relatively high coefficients at room temperature. Recently, interest in bismuth telluride has been renewed as scientists measured it as a 3D topological insulator [3]. Bismuth telluride is a relatively easy material to obtain and different compositions are being studied both as bulk material and as thin films [4,5,6].

Crystals of Bi2Te3 were Bridgman grown in a sealed quartz ampoule in a directional resistance oven at a temperature of 600°C. The crystals were slowly cooled down to room temperature and the quartz ampoule broken to retrieve the grown crystal. Conventional X-ray diffraction showed patterns compatible with a single crystal along the sample except for the starting point, which was discarded. Experiments involving XPS, ARPES and EELS on a cleaved (0001) surface sample have shown a crystal with good stoichiometry.

The grown crystals were cleaved and thin slices were cut in an Ultramicrotome (Leica UC6) with a diamond knife and deposited onto a holey carbon coated TEM grid. Alternatively they were crushed with ethanol in an agate mortar and deposited onto a carbon coated grid. High resolution transmission electron microscopy was performed on a Tecnai G2-20 from FEI at 200kV from the Microscopy Center of the Federal University of Minas Gerais (CM-UFMG).

Figure 1 shows an overview of a larger region were artifacts due to the diamond knife are visible; the direction of the cut is shown on the image. Figure 2 shows a HRTEM of the same region were strong Moiré features are visible and smaller grains with a different orientation are also shown. Samples prepared by crushing are shown on figure 3. Small grains can be observed, but the strong Moirè fringes are not so frequently observed. No grain structure was observed at the low loss spectra obtained from the surface.

Clearly there is an influence of the sample preparation method on the microstructure observed on the three HRTEM images which will be discussed.

References

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**Figure 1** - Sample prepared with an ultramicrotome showing the direction of the cut.

**Figure 2** - Smaller region of figure 1, showing lattice fringes and Moiré pattern.

**Figure 3** – Fine grain structure of the crushed sample.