ACOUSTIC AND THERMAL TRANSPORT PROPERTIES OF HARD CARBON FORMED FROM C_{60} FULLERENE

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We present acoustical and thermal transport properties of the samples of hard carbon obtained by pressurisation at 3 GPa and temperature of 973 K, as previously described [1, 2]. The samples have been characterized by X-rays, acoustic microscopy, and different electronic microscopy techniques (SEM, TEM), which show a disordered and inhomogeneous structure on very different scales from nm to μm. Acoustical and thermal transport properties have been investigated over a broad temperature and frequency (2-110 MHz) range, which reveal several properties characteristic of disordered materials:

1. The sound velocity decreases linearly with increasing temperature from 4 to 100 K.

2. The ultrasonic attenuation is strongly frequency (f) dependent, showing simultaneously a Rayleigh-like scattering regime up to 110 MHz, increasing as f^3, and a resonant regime peaked at f = 28 MHz, corresponding to a scatterer diameter of 70 μm.

3. The thermal conductivity is strictly linear in T from 20 to 300K, which confirms previous experiments [3]. This linear regime can be related to the linear decrease of the sound velocity, according to the phonon-assisted fracton hopping model of R. L. Orbach et al. established for amorphous stuctures [4]. This corresponds to a structural coherence length (density fluctuations) of 0.5-0.6 nm.

4. Below T = 10K, the thermal conductivity varies as $T^{1.4}$, and is lower than for vitreous silica by a factor ≈5-10, and without the characteristic plateau at a few K of amorphous materials. There is appearence of a boundary scattering regime around 100 mK, which corresponds to scatterers size of about 45-60 μm.

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