# *Low frequency Raman scattering and low temperature heat capacity of permanently densified $B_2O_3$ glasses*

*Giovanni Carini Jr[1], Giuseppe Carini[2], Giovanna D'Angelo[2], Mauro Federico[2]*

*[1]IPCF-CNR, UOS di Messina, I-98158 Messina, Italy*
*[2]Dipartimento di Fisica e Scienze della Terra, Università di Messina, I-98166 Messina, Italy*

Sample densification was obtained by loading $B_2O_3$ glasses (dry v-$B_2O_3$ having $H_2O$ content of 210 ppm) in a multi-anvil high temperature/high pressure apparatus for the synthesis at 5 and 6 GPa. They were kept under those pressures at room temperature for about 2-4 hrs and then the pressure was slowly released. Densified glasses were characterized by X-ray diffraction which revealed no sign of crystallization. The densities have been measured at room temperature: 1829 kg/m$^3$ (v-$B_2O_3$), 1949 kg/m$^3$ (5-GPa glass) and 1967 kg/m$^3$ (6-GPa glass). The Debye sound velocity $V_D$ $\left(\frac{3}{V_D^3}=\frac{1}{V_l^3}+\frac{2}{V_t^3}\right)$ and the elastic Debye temperature $\Theta_D$ have been determined by the values of longitudinal ($V_l$) and shear ($V_t$) sound velocities measured at room temperature: $V_l$=3261 m/s, $V_t$=1786 m/s, $V_D$=1992 m/s, $\Theta_D$=254.8 K (v-$B_2O_3$); $V_l$=3690 m/s, $V_t$=2013 m/s, $V_D$=2245, $\Theta_D$= 293.4 K (5-GPa glass); $V_l$=3760 m/s, $V_t$=2042 m/s, $V_D$=2278 m/s, $\Theta_D$=298.6 K (6-GPa glass).

Inelastic light scattering spectra of normal and permanently densified $B_2O_3$ glasses were investigated over the frequency range between 7 and 1800 cm$^{-1}$. Increasing densification gives rise to a decrease of the intensity of the strong band at 808 cm$^{-1}$, ascribed to breathing vibration of boroxol rings. Below 100 cm$^{-1}$, the Raman spectra are dominated by the Boson peak which also decreases the intensity with densification and shifts its position from about 26 cm$^{-1}$ (v-$B_2O_3$), through 28 cm$^{-1}$ (1-GPa glass), up to 31 cm$^{-1}$ (5-GPa and 6-GPa glasses). This increase results to be smaller than that expected from the hardening of the elastic continuum: the elastic moduli increase up to about a factor 1.4 compared to those of normal glass. Increasing atomic packing of the glassy network also leads to a progressive decrease of the excess specific heat capacity $C_p$ observed in v-$B_2O_3$ between 1 and 20 K (having the shape of a broad peak when reported as $C_p(T)/T^3$). These observations imply that densification drives the system toward a structure having a more efficient packing of molecular units, causing substantial variations of the medium-range order.