Nanoscale physics

Influence of cooling and heating rate on low temperature thermal conductivity of g-Ge_2S_3

V. Mitsa[1*], A. Feher[2], R. Holomb[1], S. Petretskyi[1],V. Tkac[2,3]

[1] Uzhhorod National University, Pidhirna Str., 46, 88000 Uzhhorod, Ukraine.
[2] Pavol Jozef Šafárik University in Košice, 041 54 Košice, Slovak Republic.
[3] Department of Condensed Matter Physics, Faculty of Mathematics and Physics, Charles University, Ke Karlovu 5, CZ-12116 Prague 2, Czech Republic.
E-mail: V. Mitsa: *v.mitsa@gmail.com*

The Thorpe model [1] predict increasing of nanoclusters connectivity in structural matrices of chalcogenide glasses starting at mean coordination number z=2.4 (As_2S_3). The compositional (z) changes are influenced on thermal properties of chalcogenide glasses [2]. In [2] the low temperature thermal conductivity of g-As_2S_3 in temperature range from 100 K to 2.5 K measured with cooling rate of 0.385 K/min and heating with rate of 0.415 K/min in the opposite direction was presented. This experiment revealed a hysteresis of K(T) above plateau located in the region of "boson peak". The highest connectivity in Ge-S glassy system is at z=2.8 which corresponds to g-Ge_2S_3. For this glass composition during cooling and heating with rate of v_1 = 0.5 K/min in similar temperature range as for g-As_2S_3 the hysteresis k(T) was also detected. $\Delta\kappa(T)$ reproduce the density of state in a $g(\omega)/\omega^2$ representation estimated from a Boson peak (BP) experimentally obtained by Raman measurements at room temperature. Δk (T) in g-Ge_2S_3 is shifted in high energy side in comparison with Δk (T) of g-As_2S_3. It correlates with the "blue" shifting of boson maximum (ν_B) in g-Ge_2S_3, ν_B=32 cm^{-1} in comparison with its position in g-As_2S_3, ν_B = 26 cm^{-1}. During cooling and heating of g-Ge_2S_3 with rate of v_2 = 0.2 K/min the difference of Δk (T) is small and hysteresis appears weaker. The region of "plateau" in g-Ge_2S_3 is significantly wider and covered the temperature range from 10 to 40 K in comparison with the region of "plateau" in g-As_2S_3 (3.6 K and 10.7 K). The increases in k(T) values in g-Ge_2S_3 in comparison with those found in g-As_2S_3 correlates well with the increasing of sound velocity in g-Ge_2S_3 relating g-As_2S_3. Role ring correlations in random networks is discussed.

1. *M. F. Thorpe and Y. Cai*. Mechanical and Vibrational Properties of Network Structures // J. Non-Cryst. Sol. - 1989. - **114**. P.19–24.
2. *V. Mitsa, A. Feher, S. Petretskyi, R. Holomb, V. Tkac, P. Ihnatolia and A. Laver*. Hysteresis of low-temperature thermal conductivity and Boson peak in glassy (g) As_2S_3: nanocluster contribution // Nanoscale Research Letters - 2017 - 12:345. **DOI:** 10.1186/s11671-017-2125-6.