



# COMPARATIVE ANALYSIS OF THERMAL CONDUCTIVITY OF POLYMERS UNDER VARYING TEMPERATURE AND PRESSURE

V.V. Sagan, V.A. Konstantinov

e-mail: sagan@ilt.kharkov.ua

B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine

Polymeric materials exhibit complex thermal transport behavior due to their structural heterogeneity, molecular architecture, and varying degrees of disorder. Unlike crystalline solids, polymers frequently contain amorphous and partially ordered regions, resulting in heat transfer mechanisms that are strongly influenced by external thermodynamic parameters such as temperature and pressure. Changes in these parameters affect intermolecular interactions, free volume, and chain dynamics, thereby modifying thermal conductivity.

Despite significant progress in understanding heat transfer in polymers, the combined influence of temperature and pressure on thermal conductivity remains insufficiently explored. This issue is particularly important because polymers often possess relatively large thermal expansion coefficients and pronounced structural flexibility, making their thermal properties highly sensitive to thermodynamic conditions.

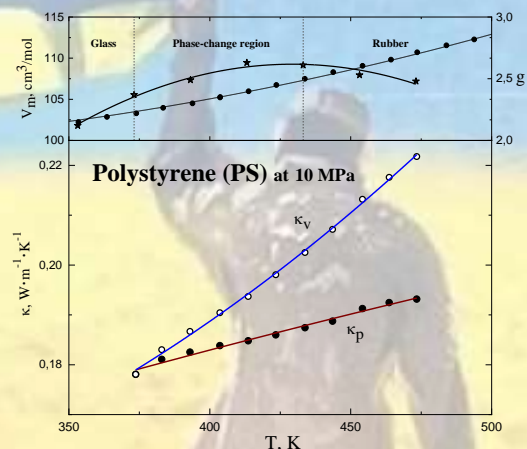
Among amorphous polymers, polystyrene (PS) and polycarbonate (PC) are representative model systems due to their well-characterized pressure–volume–temperature behavior. Experimental studies have shown that thermal conductivity in PS and PC strongly depends on both temperature and pressure, highlighting the important role of compressibility and volume effects [3]. Although these materials exhibit relatively small Bridgman coefficients, significant differences between isobaric and isochoric thermal conductivity arise because of their large thermal expansion.

In this work, a comparative analysis of thermal conductivity in polymers under varying temperature and pressure is presented, with particular emphasis on PS and PC as model systems for understanding the mechanisms governing thermal transport in disordered polymeric materials.

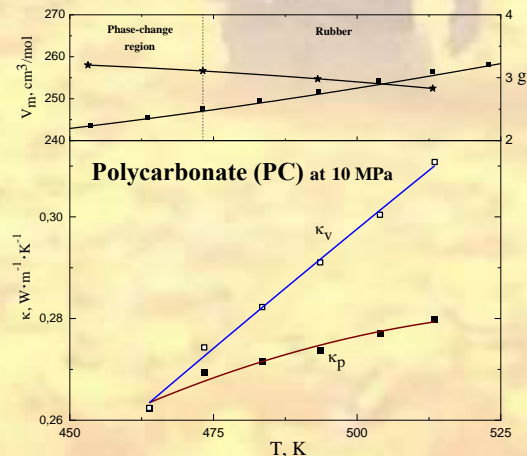
**Table 1.** Total molar volume change from absolute zero to indicated temperature  $\Delta V/V_0\%$ ,  $T_m$  is the temperature of the phase transition,  $t$  is the glass transition,  $m$  is melting,  $g = -(d \ln \kappa / d \ln V)_T$  is the Bridgman coefficient,  $T_g$  is temperature at which  $g$  was determined,  $\Delta \kappa/\kappa = g \Delta V/V_0$ .

Substance	$\Delta V/V_0$ %	$T_m$ K	Phase change	$\beta$	$T_g$ K	$\Delta \kappa/\kappa$ %	Reference
Polystyrene ( $C_8H_8$ ) <sub>n</sub>	18.5*	-373	t	2.2	350	40	[1-4]
Polycarbonate ( $C_{16}H_{14}O_2$ ) <sub>n</sub>	17.5*	-420	t	2.7	400	47	[3]

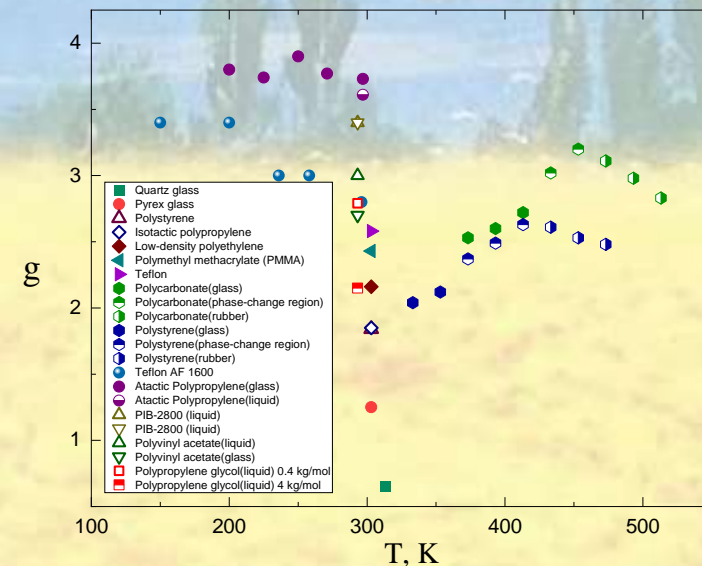
\*-Calculated from thermal expansion coefficients



**Fig. 1.** Isobaric ( $P=10$  MPa) and isochoric ( $V_m$  is fixed at  $T=462$  K) thermal conductivities of solid polycarbonate. The top figure shows the dependencies of  $V_m(T)$  (squares) and  $g(T)$  (asterisks).



**Fig. 2.** Isobaric ( $P=10$  MPa) and isochoric ( $V_m$  is fixed at  $T=375$  K) thermal conductivities of solid polystyrene. The top figure shows the dependencies of  $V_m(T)$  (rings) and  $g(T)$  (asterisks).



**Fig. 3.** The Bridgman coefficient  $g$  of plastics and glasses.

## References

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