

# The importance of a class of secondary relaxation process in glass-forming liquids

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Broadband dielectric spectroscopy is a very powerful tool for the investigation of relaxation dynamics of glass forming liquids because it can monitor the reorientational motions of molecular dipoles over many decades of frequency. In the dielectric spectra of even simple glass formers, more than one relaxation process can be identified. The most prominent one is the  $\alpha$ -relaxation associated with motion of the entire molecule that reorganizes the "liquid structure". Faster than the structural  $\alpha$ -relaxation, there is one or more than one relaxation process known as the secondary process. An important aspect concerning the relaxation dynamics of glass forming materials is the investigation of the molecular origin of the secondary relaxation and its possible connection to the structural relaxation and thus glass transition

The term, secondary or  $\beta$ -relaxation, has been commonly used to designate the relaxation modes faster than the structural relaxation. Since the molecular mechanism underlying the  $\beta$ -relaxation can be distinct for different systems, there is an obvious need to classify them according to properties. Some of these have intramolecular character and are related to the specific motion of a moiety within the molecule. The secondary relaxation also exists in rigid molecules that lack internal degree of freedom, and certainly they have intermolecular origin. For the first time this type of secondary relaxation was found by Johari and Goldstein in simple, low-molecular weight glass-forming liquids. Consequently it has been recently proposed in literature to call only this type of  $\beta$  relaxation as the Johari-Goldstein (JG-) relaxation in order to distinguish it from such secondary relaxations that have intramolecular origin [1].

From experimental point of view the most challenging task is the identification of the true JG process [2-5]. In this work we present results of both isothermal and isobaric dielectric measurements in number of glass forming liquids. Dielectric spectra of all studied material exhibit secondary relaxations. From the observed properties and the changes with applied pressure, we are able to identify the true JG processes that are the initiator of the structural relaxation and fundamental in the understanding of the many-molecule dynamics in glass transition. The experimental findings are discussed in term of the Coupling Model, the primitive relaxation time of which is remarkably close to the observed JR relaxation time.

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## References

- [1] K.L. Ngai and M. Paluch, *J. Chem. Phys.* **120** (2004) 857.
- [2] M. Paluch, S. Pawlus, S. Hensel-Bielowka, E. Kaminska, D. Provesto, S. Capaccioli, P. A. Rolla, and K. L. Ngai, *J. Chem. Phys.* **123** (2005) 234506.
- [3] S. Maslanka, M. Paluch, W. W. Sulkowski, and C. M. Roland, *J. Chem. Phys.* **122** (2005) 084511.
- [4] S. Pawlus, S. Hensel-Bielowka, M. Paluch, R. Casalini and C. M. Roland, *Phys. Rev. B* **72** (2005) – in print.
- [5] S. Hensel-Bielowka, M. Paluch, and K.L. Ngai *J. Chem. Phys.* **123** (2005) 014502.