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# **The Glass Transition**

Relaxation  
Dynamics  
in Liquids  
and Disordered  
Materials



Springer

# Glab Transition Relaxation Dynamics In Liquids And Disordered Materials

**Toyoyuki Kitamura**



## **Glab Transition Relaxation Dynamics In Liquids And Disordered Materials:**

**The Glass Transition** Ernst-Joachim Donth, 2001-06-06 Describes and interrelates the following processes cooperative alpha processes in a cold liquid structural relaxation in the glass near  $T_g$  the Johari Goldstein beta process the Williams G tze process in a warm liquid fast nonactivated cage rattling and boson peak and ultraslow Fischer modes [Physics Briefs](#), 1994 *Relaxation Dynamics in Disordered Systems* Michela Romanini, 2015 The nature of the glass transition and of the glassy state is a fundamental and still unsolved problem of condensed matter physics Many liquids can be supercooled below their melting point without crystallizing that is without acquiring translational and orientational order As the temperature of a supercooled liquid is lowered the characteristic timescale of molecular motions called relaxation time increases until it becomes comparable to the timescale of human experimentation This takes place at the glass transition temperature and leads to a non equilibrium state of matter called a structural glass in which a liquid like lack of order is combined with solid like elastic properties Glass transitions are also observed in systems where there is only orientational disorder such as orientationally disordered OD crystals or plastic crystals which are translationally ordered solids in which the constituent molecules display reorientational motions about their centres of mass Upon supercooling an OD crystal the orientational disorder can freeze yielding a so called orientational glass In molecular materials forming structural or orientational glasses the most important molecular dynamics process is the cooperative motion of the molecules referred to as primary relaxation whose freezing marks the transition to the glass state characterized by static disorder The main difference between orientational and structural glasses is that in the former the freezing involves exclusively the rotational degrees of freedom of the molecules while in the latter all six molecular degrees of freedom i e both orientational and translational ones are frozen Orientational glasses are therefore systems with fewer degrees of freedom than structural glasses This simplification together with the fact that many OD phases are characterized by a crystal lattice with high symmetry makes OD phases a model playground to investigate the nature of the glass transition Other than the primary relaxation there can be also so called secondary relaxations usually characterized by shorter relaxation time than the primary process Secondary relaxations may have different origins for example they can be due to conformational fluctuations or intramolecular vibrations in many cases a special kind of secondary relaxation is observed which is the single molecule precursor process of the primary relaxation This thesis focuses on the effect of pressure and temperature on the dynamics of several pure compounds and binary mixtures forming structural or orientational glasses We present a comparative study between two structural glass formers ternidazole and the mixture of m fluoroaniline with m xylene a plastic binary mixed crystal neopentyl alcohol and neopentyl glycol and two materials displaying statistical orientational disorder 2 adamantanone and pentachloronitrobenzene In all cases a primary relaxation is present associated with the collective motion of the molecules and in most cases also secondary relaxations are observed For each material we analyse the temperature and pressure dependence of the various

molecular relaxation and discuss the origin of secondary processes One of the most important results of the thesis is the presence of secondary relaxations also in systems with low dimensional disorder that behave similarly to the secondary relaxations observed in structural glasses **Dissertation Abstracts International** ,1985-05 **Relaxation and Diffusion in Complex Systems** K.L. Ngai,2011-03-25 The usefulness of the book to the reader is exposure to many different classes of materials and relaxation phenomena They are tied together by the universal relaxation and diffusion properties they share and a consistent explanation of their origin The readers can apply what they learn to solve their own problems and use it as a stepping stone to make further advances in theoretical understanding of the origin of the universality **Science Citation Index** ,1993 Vols for 1964 have guides and journal lists **Dynamics of Disordered Materials** Dieter Richter,1989 Liquid Glass Transition Toyoyuki Kitamura,2012-12-31 A glass is disordered material like a viscous liquid and behaves mechanically like a solid A glass is normally formed by supercooling the viscous liquid fast enough to avoid crystallization and the liquid glass transition occurs in diverse manners depending on the materials their history and the supercooling processes among other factors The glass transition in colloids molecular systems and polymers is studied worldwide This book presents a unified theory of the liquid glass transition on the basis of the two band model from statistical quantum field theory associated with the temperature Green s function method It is firmly original in its approach and will be of interest to researchers and students specializing in the glass transition across the physical sciences Examines key theoretical problems of the liquid glass transition and related phenomena Clarifies the mechanism and the framework of the liquid glass transition Liquid to Solid Without Order Yuxing Zhou,2017 Glasses are non equilibrium disordered solids that constitute a wide range of natural and engineered materials including silicate glasses plastics colloidal suspensions and foams Despite decades of research the nature of the glass transition whereby liquids transform to glasses under rapid cooling or compressing is still a matter of debate According to many leading glass theories the dramatic slowing down of dynamics with decreasing temperature or increasing concentration a key signature of the glass transition is attributed to some underlying growing length scale While a number of methods have been proposed identifying the length scale relevant to the sluggish dynamics in glass forming liquids remains elusive since after all glasses are defined not by a common feature they share but rather something they all lack order In this thesis we combine computational and theoretical approaches to study the dynamics and structures in glass forming colloidal hard spheres which is the simplest model glass former and theoretically more tractable as well as realistic polymer systems First we develop a novel crystal avoiding method to suppress crystallization while preserving the dynamics of monodisperse hard spheres which allows us to probe the long time dynamics of the system in metastable equilibrium and offers new opportunities to examine the effect of size polydispersity Then we introduce a purely geometric criterion for the glass transition in monodisperse hard spheres based on potentially caged particles that are restricted to neighbor rearrangement We also propose a graph theory based method combining Voronoi

tessellation and graph isomorphism to explicitly enumerate distinct inherent structures and thereby obtain the structural entropy We find a finite structural entropy at the glass transition volume fraction for both hard disks and hard spheres When applied to identify locally preferred structures the graph method reveals growing icosahedral clusters in random dense hard spheres whose lifetime increases significantly as the system is densified Finally we expose the hidden correlation lengths in glass forming systems from the dynamical response to external perturbations pinned particles in colloidal hard spheres and free surfaces in polymer thin films We find the correlation lengths obtained in both systems increase moderately as the glass transition is approached and correlate to the unperturbed structural relaxation times as predicted by some theories

*Liquids, Freezing and Glass Transition* Jean-Pierre Hansen,D. Levesque,Jean Zinn-Justin,1991      **Dynamics of Disordered Materials II** A. J. Dianoux,W. Petry,D. Richter,1993      **Theory of Rigidity Transitions in Disordered Materials** Robbie Rens,2019      New Kinds of Phase Transitions: Transformations in Disordered Substances V.V. Brazhkin,S.V Buldyrev,V.N. Ryzhov,Harry Eugene Stanley,2002-08-31 Phase transitions are involved in phenomena ranging from the initial stages of the creation of the Universe to the existence of biological objects It is natural to ask whether any phenomena analogous to phase transitions are possible in disordered substances like liquids and glasses The possibility of such transitions is still very much a matter of debate Neither the nature nor the features of transformations in liquids and glasses are yet clear nor is the nature of the order parameters Investigations in recent years have shown that transformations in liquids and glasses lead to a drastic change of their physical properties and short range order structure The papers collected here contribute to a better understanding of the physics of disordered systems and phase transformations in them An unambiguous identification of transitions in liquids and glasses requires further high precision experimental study of the thermodynamic and structural properties in the vicinity of transitions in order to test existing theoretical models and develop new more accurate ones      **Numerical Studies Of Slow Dynamics And Glass Transition In Model Liquids** ,2002      Dynamics of Disordered Materials II Forschungszentrum Jülich. Institut für Festkörperforschung,Institut Laue-Langevin,1993      Glass Transition and Phase Transitions in Food and Biological Materials Jasim Ahmed,Yrjö H. Roos,Shafiu Rahman,Suprakas Sinha Ray,2017      **Disorder Effects on Relaxational Processes** Ranko Richert,Alexander Blumen,2011-12-13 The field of non crystalline materials has seen the emergence of many challenging problems during its long history In recent years the interest in polymeric and biological disordered matter has stimulated new activities which in turn have enlarged the organic and inorganic glass community The current research fields and recent progress have extended our knowledge of the rich phenomenology of glassy systems where the role of disorder is fundamental for the underlying microscopic dynamics In addition despite the lack of a unified theory many interesting theoretical models have recently evolved The present volume offers the reader a collection of topics representing the current state in the understanding of disorder effects as well as a survey of the basic problems and phenomena involved

The task of compiling a book devoted to disordered systems has benefited much from a seminar organized by the W E Heraeus Foundation in Bad Honnef in April 1992 where we had the opportunity to discuss the project with most of the authors Here we wish to thank the Heraeus Foundation for their support and the authors and Springer Verlag especially Dr Marion Hertel for the pleasant cooperation      The Glass Transition and the Nature of the Glassy State ,1976

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