UNIVERSITÀ DEGLI STUDI DI MILANO

Curriculum vitae

AL MAGNIFICO RETTORE
DELL'UNIVERSITA' DEGLI STUDI DI MILANO **COD. ID: 5410**

Il sottoscritto chiede di essere ammesso a partecipare alla selezione pubblica, per titoli ed esami, per il conferimento di un assegno di ricerca presso il **Dipartimento di Fisica "Aldo Pontremoli"**

Responsabile scientifico: **Prof. Alessio Zaccone**

VINAY VAIBHAV

CURRICULUM VITAE

INFORMAZIONI PERSONALI

Cognome	Vaibhav
Nome	Vinay

OCCUPAZIONE ATTUALE

Incarico	**Struttura**
Ph.D. Student	The Institute of Mathematical Sciences, Chennai (India)

ISTRUZIONE E FORMAZIONE

Titolo	**Corso di studi**	**Università**	**anno conseguimento titolo**
Dottorato Di Ricerca	Physics Ph.D. Thesis Title: Thermo-mechanical Response of Glassy Systems Ph.D. Supervisor: Prof. Pinaki Chaudhuri	Homi Bhabha National Institute, Mumbai (India)	Thesis submitted and defense awaited, final degree expected in October, 2022
Master	Physics Masters Project Title: Heat Transport in Glass-forming Liquids Project Guide: Prof. Pinaki Chaudhuri	Homi Bhabha National Institute, Mumbai (India)	2017
Laurea Triennale	Applied Physics	Central University of Jharkhand, (India)	2015

LINGUE STRANIERE CONOSCIUTE

lingue	livello di conoscenza
Hindi	Mother Tongue
English	Fluent

PREMI, RICONOSCIMENTI E BORSE DI STUDIO

anno	Descrizione premio
2022	SERB-International travel grant from department of science and technology, Government of India, for attending a workshop in Germany
2015-22	Research fellowship from Department of Atomic Energy, Government of India

ATTIVITÀ DI FORMAZIONE O DI RICERCA

During the course of Ph.D. research, I have gained experience in studying the response of glassy systems to thermal and mechanical perturbations, in the form of a temperature gradient and shear respectively. Study of such thermal or mechanical response not only leads to the development of various important applications but also helps in understanding the out-of-equilibrium behaviour of amorphous systems, in general. I have mostly used large scale computer simulations to put a model system under the influence of a thermal gradient or mechanical drive, then to record the spatio-temporal response with microscopic details, soon after applying the perturbation and also after long time in steady state if it can be reached. As a part of different studies, many analytical approaches and their codes have been developed and tested, along with the use of open source softwares.

Thermal response of glassy system

We have probed the behaviour of a glassy material, applying an external temperature gradient. The detailed understanding of such behaviour is important to describe and develop various natural and manmade systems: magmatic differentiation during pertrogenesis, leakage of trapped nuclear waste in glass, compositional inhomogeneity in the formation of metallic alloys, etc. We have performed extensive molecular dynamics simulations using a model binary glass-forming mixture to understand the response to a thermal gradient, by studying the coupling of heat and mass transport, in supercooled and glassy states. We have also applied a heating-cooling protocol where an appropriate thermal gradient pulse is switched on for a finite duration and then switched off (very similar to laser heating or laser ablation), to show that it is possible to tune the concentration profiles of the glassy states obtained at the end. Such protocol can be used to produce glassy materials having inhomogeneous structure.

Related article: V. Vaibhav, J. Horbach, and P. Chaudhuri, Phys. Rev. E **101**, 022605 (2020).

Controlled mechanical failure of thermally processed glass

We have studied the mechanical response of glassy states which have been exposed to a thermal gradient pulse leading to a density inhomogeneity, using large scale numerical simulations. Such study can be helpful to understand the pathway to failure (shear band formation) in systems like metallic glasses where inhomogeneity is inherently present due to manufacturing process, and also to develop fine-tune engineered processes which could generate materials with desired properties. The shear-response of the thermally processed samples has been studied by deforming the sample at fixed shear-rates. We observe that the timescale for emergence of the non-equilibrium steady state under shear depends upon the thermal processing, which consequently affects the formation of shear-bands in the transient regime.

Related article: V. Vaibhav, J. Horbach, and P. Chaudhuri, under preparation (2022).

Poiseuille flow of soft glass: role of thermalization protocol

A flow through a channel or pipe due a pressure gradient is called Poiseuille flow and this is common to many natural systems and applications like microfluidic devices, 3D printing etc, involving soft glasses exhibiting finite yield stress. Understanding the flow properties of glassy materials, which make a large part of the amorphous family, in such setup can help us to develop various applications. We have performed a numerical study to develop a microscopic understanding of how two different temperature control mechanisms with varying forcing strength affect the Poiseuille flow of a soft glass. The first one is a *wall thermostat* where we use the confining walls to thermalize the system, leading to a steady non-uniform temperature profile across the channel. In the second method, a thermostat (*DPD thermostat*) is directly applied to the confining fluid while walls are frozen, resulting no temperature variation across the channel. We compare the steady flow properties of the glassy material in the two thermalization protocols and also with Couette flow under similar conditions. This study will help in developing flow based applications where Poiseuille setup of yield-stress materials can be controlled via appropriate thermal setup.

Related article: V. Vaibhav, and P. Chaudhuri, Physics of Fluids **33**, 053103 (2021).

Glassy binary mixture with large size bidispersity: interdiffusion and rheology

In nature or in our daily life, we see a variety of materials where the constituent particles can have a large dispersity in sizes. Most of the studies that have happened to explore various aspects of glassy systems, use a model binary mixture where the size of the particles are comparable. In particular, the rheological properties of mixtures with large size asymmetry have not been much explored. We have considered a model binary mixture with large size bidispersity, known to show large separation in relaxation timescales of the larger and smaller species as the density of the system is increased. We have measured single particle diffusion and the collective interdiffusion, to elucidate that there is finite-size effects in the self-diffusion of the bigger species, which can be removed if the calculation of single particle quantities of larger and smaller species are done in their respective center of mass frames. Further, we have studied the shear response of the same binary mixture with large size ratio, to understand the interplay of intrinsic timescales with the external timescale introduced via shear. We have also explored the onset of rigidity in such mixtures. Further, we measure single particle quantities to understand the behaviour of the system at microscopic level. From these micro and macro measurements, we conclude a density dependent response of the two species in the system. To investigate the role of smaller species in the rheology, we perform simulations varying the composition of the system and conclude that adding smaller particles makes system softer, i.e. reduces the measured viscosity.

Related articles: V. Vaibhav, J. Horbach, and P. Chaudhuri, Soft Matter **18,** 4427-4436 (2022); V. Vaibhav, J. Horbach, and P. Chaudhuri, J. Chem. Phys. **156**, 244501 (2022)

CONGRESSI, CONVEGNI E SEMINARI

Data	**Titolo**	**Sede**
08 Jul. 2022	Visited Prof. Peter Sollich's group Seminar Talk: Thermo-mechanical response of glassy systems	University of Goettingen (Germany)
04-07 Jul. 2022	New Frontiers in Liquid Matter Poster: Mechanical response of an inhomogeneous glass obtained via thermal processing	Sorbonne University, Paris (France)
19-21 Apr. 2022	Numerical Techniques for Nonequilibrium Steady States Poster: Mechanical response of thermally processed glass	MPI for Polymer Research, Mainz (Germany)
16 Apr. 2022	Chennai Soft Matter Day 2022 Talk: Rheology of a glassy binary mixture with large size ratio	IIT-Madras, Chennai (India)
21-25 Mar. 2022	STATPHYS KOLKATA XI Talk: Glassy binary mixture with large size ratio: interdiffusion and rheology	IISER Kolkata (India)
14-18 Mar. 2022	APS March Meeting 2022 Talk: Rheological Response of a Colloidal Glass with Large Size Bidispersity	Chicago (USA)
13-15 Dec. 2021	Complex Fluids 2021 Poster: Influence of Thermalization Protocol on Poiseuille Flow of Confined Soft Glass	IIT-Gandhinagar (India)

18 Mar. 2019	Institute Seminar Day 2019 Talk: Coupling of Heat and Mass Transport in Liquids	IMSc, Chennai (India)
19-21 Feb. 2020	7th Indian Statistical Physics Community Meeting Poster: Rheological Response of Binary Mixtures with Large Size Ratio	ICTS-TIFR, Bangalore (India)
5-7 Feb. 2020	FracMeet 2020 Poster: Response of Glassy Liquids to Thermal Gradients	SRM-AP, Amravati (India)
11-13 Dec. 2019	Recent Topics in Statistical Mechanics 2019 Poster: Response of Glassy Liquids to Thermal Gradients	NISER, Bhubaneshwar (India)
14-16 Feb. 2019	6th Indian Statistical Physics Community Meeting Poster: Response of Glassy Liquids to Thermal Gradients	ICTS-TIFR, Bangalore (India)
17 Sep.- 05 Oct. 2018	Entropy, Information and Order in Soft Matter Poster: Response of Glassy Liquids to Thermal Gradients	ICTS-TIFR, Bangalore (India)
04-15 Jun. 2018	National Summer School on Statistical Physics Poster: Transport in Binary Mixtures: Response to Thermal Gradient	SNBNCBS, Kolkata (India)
07-09 May 2018	HBNI Research Scholars Meet on Material Science and Engineering of Nuclear Materials Talk: Transport in Binary Mixtures: Response to Thermal Gradient	IGCAR, Kalpakkam (India)

PUBBLICAZIONI

Articoli su riviste
V. Vaibhav, J. Horbach, and P. Chaudhuri, "Rheological response of a glass-forming liquid having large bidispersity", Soft Matter **18**, 4427 (2022)
V. Vaibhav, J. Horbach, and P. Chaudhuri, "Finite-size effects in the diffusion dynamics of a glass-forming binary mixture with large size ratio", The Journal of Chemical Physics **156**, 244501 (2022)
V. Vaibhav,, and P. Chaudhuri, "Influence of thermalisation protocol on Poiseuille flow of confined soft glass", Physics of Fluids **33**, 053103 (2021)
V. Vaibhav, J. Horbach, and P. Chaudhuri, "Response of Glassy Liquids to Thermal Gradients", Physical Review E **101**, 022605 (2020)
D. K. Mishra, N. Chandra, and V. Vaibhav, "Equilibrium properties of blackbody radiation with an ultraviolet energy cut-off", Annals of Physics **385**, 605 (2017)

ALTRE INFORMAZIONI

Computational Skills
Operating System: Unix, Linux, Mac OS, Windows OS
Languages: C/C++ (with openMP and MPI), Python, Shell script
Software Packages: LAMMPS, LaTeX, gnuplot, Mathematica, VMD, Ovito, Office

Teaching experience
Advanced Condensed Matter Physics (Jan.-Apr. 2019)
Teaching Assistant at The Institute of Mathematical Sciences, Chennai
Instructor: Prof. Pinaki Chaudhuri

Statistical Mechanics I (Jan.-Apr. 2018)
Teaching Assistant at The Institute of Mathematical Sciences, Chennai
Instructor: Prof. Satyavani Vemparala

Le dichiarazioni rese nel presente curriculum sono da ritenersi rilasciate ai sensi degli artt. 46 e 47 del DPR n. 445/2000.

Il presente curriculum, non contiene dati sensibili e dati giudiziari di cui all'art. 4, comma 1, lettere d) ed e) del D.Lgs. 30.6.2003 n. 196.

RICORDIAMO che **i curricula SARANNO RESI PUBBLICI sul sito di Ateneo** e pertanto si prega di non inserire dati sensibili e personali. Il presente modello è già precostruito per soddisfare la necessità di pubblicazione senza dati sensibili.

Si prega pertanto di **NON FIRMARE** il presente modello.

Luogo e data: Chennai (India), September 20, 2022