REBOND NEWSLETTER

IOANNINA 2025

THIRD PROJECT MEETING

8-11 OCTOBER, 2025

Rebond MSCA DOCTORAL NETWORK

Funded by the European Union

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TRAINING MODULES

DAY 1
8/11/2026

Welcomed by the unexpectedly cool weather of the Greek mainland and the gentle humidity of the lake in Ioannina, we headed to the "Karolos Papoulias" Conference Centre to begin the training modules that accompanied us throughout the following two days. The activities focused mainly on Dielectric Spectroscopy and Fluorescence Correlation Spectroscopy, alongside presentations on wetting of polymer, offering participants an important opportunity for both theoretical and practical insight into these topics.

Introduction to Dielectric Spectroscopy and applications

By G. Floudas

Dielectric spectroscopy is a powerful technique for investigating how materials respond to an applied electric field, providing insights into their internal structure and molecular dynamics. As emphasized by George Floudas, the method allows researchers to probe how dipoles within a material respond over a broad range of frequencies, enabling exploration of processes across different time and length scales. One of the key strengths of dielectric spectroscopy is its ability to reveal relaxation phenomena as well as phase transitions and dynamic heterogeneity in complex systems. This makes it especially useful for studying polymers, glasses, and other soft materials, where subtle molecular motions strongly influence overall performance.

By linking microscopic molecular behavior to macroscopic properties, the technique continues to contribute to a deeper understanding of materials and supports the design of more efficient and tailored systems for modern technologies.

SOFT MATTER PHYSICS LAB VISIT

The day then continued with a tour of Professor Floudas' laboratories. Thanks to the support of the PhD students in the group, we had the opportunity to gain a closer understanding of the available instrumentation, its applications, and the different sample preparation procedures, experiencing firsthand the daily research activities of the laboratory.

TRAINING MODULES

DAY 2
9/11/2026

Wetting of polymers
By Prof. Dr. Hans-Juergen Butt

Understanding how liquids interact with polymer surfaces is an important topic in modern materials science, with implications for everything from waterproof coatings to biomedical devices. Research by Butt has helped shed light on this everyday, yet complex, phenomenon. His work shows that, unlike rigid materials, polymers can subtly change their surface structure over time, influencing how liquids spread or bead up. These insights reveal that wetting is not just a static property but can evolve. By improving our understanding of these interactions, scientists and engineers are better equipped to design smarter surfaces—whether to repel water, enhance adhesion, or control fluid flow in small-scale technologies.

Fluorescence correlation Spectroscopy: basic principles and typical applications
By Dr. Kaloian Koynov

Fluorescence Correlation Spectroscopy (FCS) is a powerful technique that allows scientists to study the motion and interactions of molecules at extremely small scales. Through the work of Kaloian Koynov, the method has been widely applied to soft matter and polymer systems, offering valuable insights into how molecules diffuse, aggregate, or react in solution.

This approach has become an essential tool in fields ranging from materials science to biology, where it is used to investigate processes such as polymer dynamics, protein interactions, and transport phenomena.

Broadband dielectric spectroscopy combined with rheology and scattering techniques
By Dr. J. Mattsson

Broadband dielectric spectroscopy (BDS) is a versatile technique used to probe how materials respond to electric fields across a wide range of frequencies. In the work of Johan Mattsson, BDS is often combined with rheology and scattering methods to build a more complete picture of soft and complex materials.

Linking electrical response with mechanical behavior and structural information helps to reveal how microscopic dynamics translate into macroscopic properties. These combined techniques are particularly valuable for studying polymers, colloids, and glassy systems, enabling researchers to better understand and tailor materials for applications ranging from industrial processing to advanced functional materials.

DC PRESENTATIONS

DAY 2
9/11/2026

During the afternoon of the third day, the project meeting took place, representing one of the central moments of the event. Each candidate was given the opportunity to present their project, share research progress, and discuss results with the PIs and the other students involved in the network. The discussion proved particularly stimulating and constructive, allowing everyone to place their work within the broader perspective of the overall project.

Arcangela Russo
UOC / UCLouvain

Vitrimers are polymers with reversible covalent bonds that allow reshaping while remaining elastic. This study examines well-defined polyisoprene-based vitrimers made from aldehyde-functionalized chains and amine crosslinkers. The initial networks are metastable and evolve during annealing. Annealing drives bond exchange and cluster reorganization within the material. This results in increased stiffness and energy dissipation (higher moduli). Structural data show growth of clusters and larger characteristic spacing. Higher crosslink density leads to stronger mechanical effects. Annealing is key to achieving optimal properties.

Balint Magyari
UN / UOC

Phase separation in vitrimer/homopolymer mixtures is a phenomenon with limited understanding. To validate the theory of entropy-induced phase separation developed by Alessandros Rispo Constantinou, a molecular dynamics simulation protocol has been created. When a system with known vitrimer/homopolymer proportion is created, the onset of phase separation will depend on the crosslinking density in the mixture. By varying the proportion of crosslinked sites, the onset of phase separation can be estimated through MD simulations. Results based on the spatial density of vitrimer beads were used to determine the critical crosslinking density, above which phase separation develops spontaneously. These results were later mapped on the phase diagram resulting in a close match between theory and simulations.

DC PRESENTATIONS

DAY 2
9/11/2026

Stefano Chiani
UOI / ESPCI

During my presentation in Ioannina, I discussed a study on incorporating vitrimer networks into HDPE to enhance recyclability and performance, analyzing five samples with increasing crosslinker content. Using DSC and SAXS/WAXS, I showed that vitrimer domains are mainly located in the amorphous regions, affecting chain mobility and promoting earlier lamellar thickening without significantly altering the crystalline structure. Finally, dielectric spectroscopy revealed increased molecular dynamics and a decrease in glass transition temperature as the vitrimer content rises.

Guisi Merola
ESPCI / Hutchinson / UCLouvain

Explores the development of vitrimer elastomers through the synthesis of a high molecular weight polydisperse alkyl acrylate copolymer using FRP polymerization. The best strategy to functionalize into vitrimer precursors was investigated through condensation with phenylboronic acid.

Matteo Conti
ESPCI / UCLouvain

Synthesis and characterization of amorphous elastomeric and vitreous polystyrene, polymethacrylate, polybutylmethacrylate and polybutylacrylate dioxaborolane-based vitrimers. Focusing on designing them with different molar masses, dispersities, glass-transition temperatures to then study the impact of these parameters on the thermomechanical properties

DC PRESENTATIONS

DAY 4
10/11/2026

Anahita Karimi
UCLouvain / UG

In my project, we investigate polyethylene (PE) dynamic covalent adaptable networks (CANs) prepared via reactive extrusion using two different cross-linkers at varying concentrations. Our results show that faster cross-linkers significantly improve processability, while adjusting their proportion enables precise tuning of elasticity and relaxation behavior. We observe clear thermo-rheological complexity, arising from the distinct temperature dependence of reversible bond exchange and polymer segmental dynamics. Interestingly, Time Marching Algorithm (TMA, based on the tube model) modeling results reveals that the effective cross-link density is significantly lower than theoretical predictions, highlighting the need for refined modeling approaches. Additionally, the mechanical response of these dynamic networks appears more sensitive to shear than to temperature. Ongoing work focuses on improving the predictive capability of our model, particularly in the low-frequency regime, and extending elongational rheology measurements for highly cross-linked systems.

Konstantina Lyroni
UM / UOC

In my presentation, we were focusing on the mechanodynamics of polymers with dynamic covalent bonds. In particular, we studied PnBA dioxaborolane & diols along with their corresponding vitrimers, as well as gluten networks. We concluded that PnBA dioxaborolane materials evolve overtime, but they have different rheological behavior: the polymer is entangled while the vitrimer is crosslinked. Similar results were also presented for the case of PnBA diol materials, however, they exhibit faster dynamics than the PnBA dioxaborolanes. Lastly, the gluten networks that were examined are aging overtime and exhibit the behavior of a viscoelastic liquid

DC PRESENTATIONS

DAY 3
10/11/2026

Alexandros Andreas Rispo Constantinou
UN / UCLouvain

Polymer/vitrimer blends are prone to separation at high crosslinking fractions.” In collaboration with DC12, we investigate the truth of this statement using two approaches: one statisticomechanical, the other simulative (molecular dynamics). Preliminary results suggest agreement between the two approaches, and predict that separation occurs earlier as the vitrimer is increasingly diluted — thus setring a threshold on its use as a mechanical additive.

Arya Vijayan
UCLouvain / UOI

During the Ioannina meeting, I presented the synthesis of PS-PMMA random copolymers by RAFT and FRP and its characterization results. And also the synthesis of monomers for vitrimer synthesis.

Anthi Sapouna
UCLouvain / UOI

During the meeting in Ioannina, we discussed the evolution of the composition and properties of degraded HDPE, focusing on the thermal, molecular, and mechanical properties of the degraded samples. In addition, the influence of the addition of different amounts of vitrimers on degraded HDPE was examined through thermal and mechanical characterization. Finally, the development of predictive tools to improve the processing and mechanical properties of recycled HDPE was presented.

DC PRESENTATIONS

DAY 3
10/11/2026

Teresiana Guarino
UOC / UM

The presentation updates the audience on the progresses of the rheological characterization of polystyrene vitrimers, at different crosslinker concentrations, focusing on the linear viscoelasticity and the uniaxial extensional rheology. In addition, experimental techniques for proving biaxial extensions were presented, showing preliminary results on the response of cross-linked rubbers, obtained using an home made setup based on the bubble inflation technique.

Lorenzo Santori
UG / ESPCI

Vitrimers are polymer networks that combine the stability of thermosets with the reprocessability of thermoplastics through dynamic bond exchange. Blending vitrimers with linear polymers is a promising strategy to tune material properties while maintaining processability. In this work, the rheological behavior of extruded blends of polystyrene (PS)-based vitrimers with linear PS is investigated. Blends were prepared by melt extrusion and characterized using linear viscoelastic measurements and microscopy. The vitrimer material shows slow structural evolution during thermal annealing, likely due to the formation of additional permanent crosslinks. When blended with PS, increasing vitrimer content introduces an additional elastic contribution to the material response, suggesting the presence of dynamic crosslinks or aggregates. Importantly, the shear-thinning behavior remains largely unchanged, indicating that the blends maintain good processability.

DC PRESENTATIONS

DAY 3
10/11/2026

Frances Abygail F. Genio
ESPCI / UG

The presentation focuses on my research which is on compatibilizing and recycling polymers through two different strategies. One involves the use of azidotriazine grafting of different polymer blends with polyethylene while second one focuses more on the blends of polyethylene and polypropylene. The latter involves the synthesis of a dynamically cross-linked polyolefin vitrimer-based compatibilizer derived from functionalized hydrogenated polybutadiene. We plan to look into the effects of these methods on the structure-property of the materials and synthesize effective dynamic compatibilizers of semi-crystalline polymers.

Claudia Spina
ESPCI / UOC

During my presentation, I discussed the progress in developing methods to analyze adhesion properties between two immiscible polymers blended with vitrimers: polystyrene and polymethyl methacrylate vitrimer each containing 10% dioxaborolane-functionalized monomer and 1% cross-linker. The presentation started with an overview of the mechanical setup for adhesion testing, followed by the introduction of the layered method, in which the adhesion is assessed not on bulk material but on a layered sample. In this approach, the vitrimers, mixed with the commercial polymers, are applied as a thin layer onto a bulk polymer substrate. This method enables high parameter variability while assuring a low vitrimer consumption. Particular attention was given to highlight two key challenges: the reproducibility and reliability of adhesion measurement and the optimization of the preparation of the thin layers to assure a defect-free and uniform surfaces for accurate adhesion testing.

DC PRESENTATIONS

DAY 3
10/11/2026

Michail Danikas
UOI / UOLeeds / UM

The presentation provided an overview of the ongoing work on the PnBMA homopolymer, the vitrimer precursor, and the 5%-crosslinked vitrimer. It began with a brief reminder of the system, followed by thermal analysis based on heat flow traces obtained from temperature-modulated DSC. Motivated by earlier studies on polystyrene based vitrimers, time dependent rheological measurements and frequency scans at fixed temperature were used to examine potential kinetic effects. To further explore the origin of the molecular processes, pressure dependent dielectric spectroscopy was used to analyze local and segmental dynamics. Temperature controlled measurements alone cannot fully separate thermal and volume contributions, since decreasing temperature
also increases density. By performing isothermal measurements at different pressures, the dependence of each relaxation process on volume changes can be evaluated. Calculation of the apparent activation volume then helps identify whether a process is mainly controlled by thermal activation, volume effects, or a combination of both.

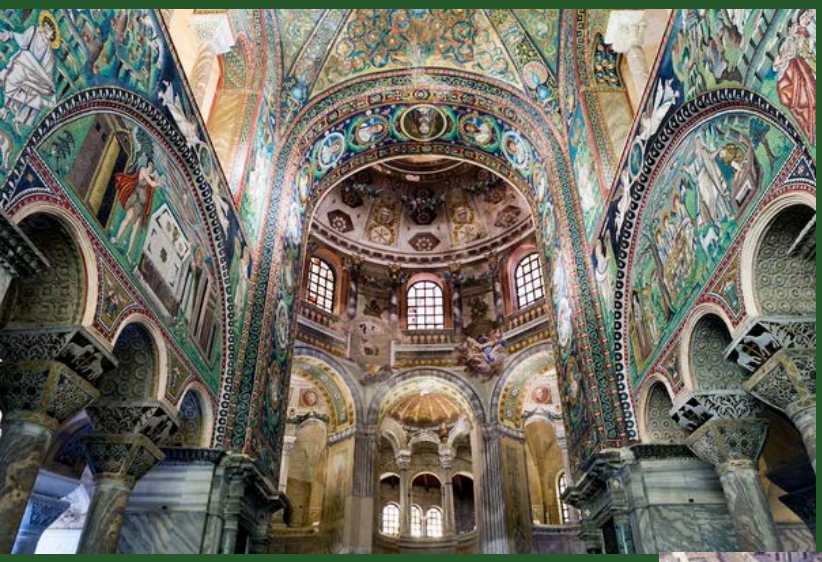
The third day of presentations concluded with the Governing Board meeting, followed by a dedicated session for the PhD students to further discuss and exchange ideas inspired by the presentations and scientific discussions shared throughout the previous days. These exchanges continued into the following day with an additional session specifically devoted to discussion and scientific interaction.

MEETING DINNER AT "FRONTZOU POLITIA"

DAY 3
10/11/2026

On the final evening, Professor Floudas welcomed us for the concluding dinner at "Frontzou Politia", where, with a wonderful view over the lake of Ioannina and in a warm and convivial atmosphere, we continued discussing not only science and research, but also the personal and professional experiences shared throughout these days.

NEXT PROJECT MEETING RAVENNA, JUNE 2026



The next project meeting will take place in Ravenna, from April 9th to 12th, in the remarkable setting of the Biblioteca Classense. The meeting will provide a further opportunity for discussion and collaboration among the network partners and will also offer participants the possibility to visit the facilities of Versalis, an industrial partner involved in the project.

Many thanks to Professor Floudas for welcoming us to his laboratory and for hosting such an engaging and enriching meeting in Ioannina. We would also like to thank all the speakers and organizers for their support, and for contributing to the success of the meeting. With this, we look forward to the next meeting and...

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Credits:

- https://www.adventourely.com/where-to-stay-in-ioannina/
- Md Anisur Rahman, Design of High Performance Vitrimers for Circular Economy, 2021
- https://www.immobiliare.it/news/mercato-immobiliare/monumenti-musei-e-edifici-storici/ravenna-citta-dei-mosaici-quali-sono-i-piu-belli-da-scoprire-354907/
- https://www.ilvaloreitaliano.it/alla-scoperta-delle-citta-darte-italiane-ravenna/