



HAL
open science

Editorial: Nanocomposites with interfaces controlled by grafted or adsorbed polymers

O. Holderer, A.-C. Genix, M. Kruteva, Julian Oberdisse

► To cite this version:

O. Holderer, A.-C. Genix, M. Kruteva, Julian Oberdisse. Editorial: Nanocomposites with interfaces controlled by grafted or adsorbed polymers. *Frontiers in Physics*, 2023, 10, pp.1117549. 10.3389/fphy.2022.1117549 . hal-04244930

HAL Id: hal-04244930

<https://cnrs.hal.science/hal-04244930>

Submitted on 16 Oct 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



OPEN ACCESS

EDITED AND REVIEWED BY
Malgorzata Biczysko,
Shanghai University, China

*CORRESPONDENCE
O. Holderer,
✉ o.holderer@fz-juelich.de

SPECIALTY SECTION
This article was submitted to Physical
Chemistry and Chemical Physics,
a section of the journal
Frontiers in Physics

RECEIVED 06 December 2022
ACCEPTED 28 December 2022
PUBLISHED 09 January 2023

CITATION
Holderer O, Genix A-C, Kruteva M and
Oberdisse J (2023), Editorial:
Nanocomposites with interfaces
controlled by grafted or
adsorbed polymers.
Front. Phys. 10:1117549.
doi: 10.3389/fphy.2022.1117549

COPYRIGHT
© 2023 Holderer, Genix, Kruteva and
Oberdisse. This is an open-access article
distributed under the terms of the [Creative
Commons Attribution License \(CC BY\)](#).
The use, distribution or reproduction in
other forums is permitted, provided the
original author(s) and the copyright
owner(s) are credited and that the original
publication in this journal is cited, in
accordance with accepted academic
practice. No use, distribution or
reproduction is permitted which does not
comply with these terms.

Editorial: Nanocomposites with interfaces controlled by grafted or adsorbed polymers

O. Holderer^{1*}, A.-C. Genix², M. Kruteva³ and J. Oberdisse²

¹Jülich Centre for Neutron Science (JCNS) at Heinz Maier-Leibnitz Zentrum (MLZ), Forschungszentrum Jülich GmbH, Garching, Germany, ²Laboratoire Charles Coulomb (L2C), CNRS, University of Montpellier, Montpellier, France, ³Jülich Centre for Neutron Science (JCNS-1 and IBI-8), Forschungszentrum Jülich GmbH, Jülich, Germany

KEYWORDS

nanocomposites, polymer grafted nanoparticles, interfacial layer, polymer and nanoparticle dynamics, structure of nanocomposites, neutron scattering, X-ray scattering, computer simulations

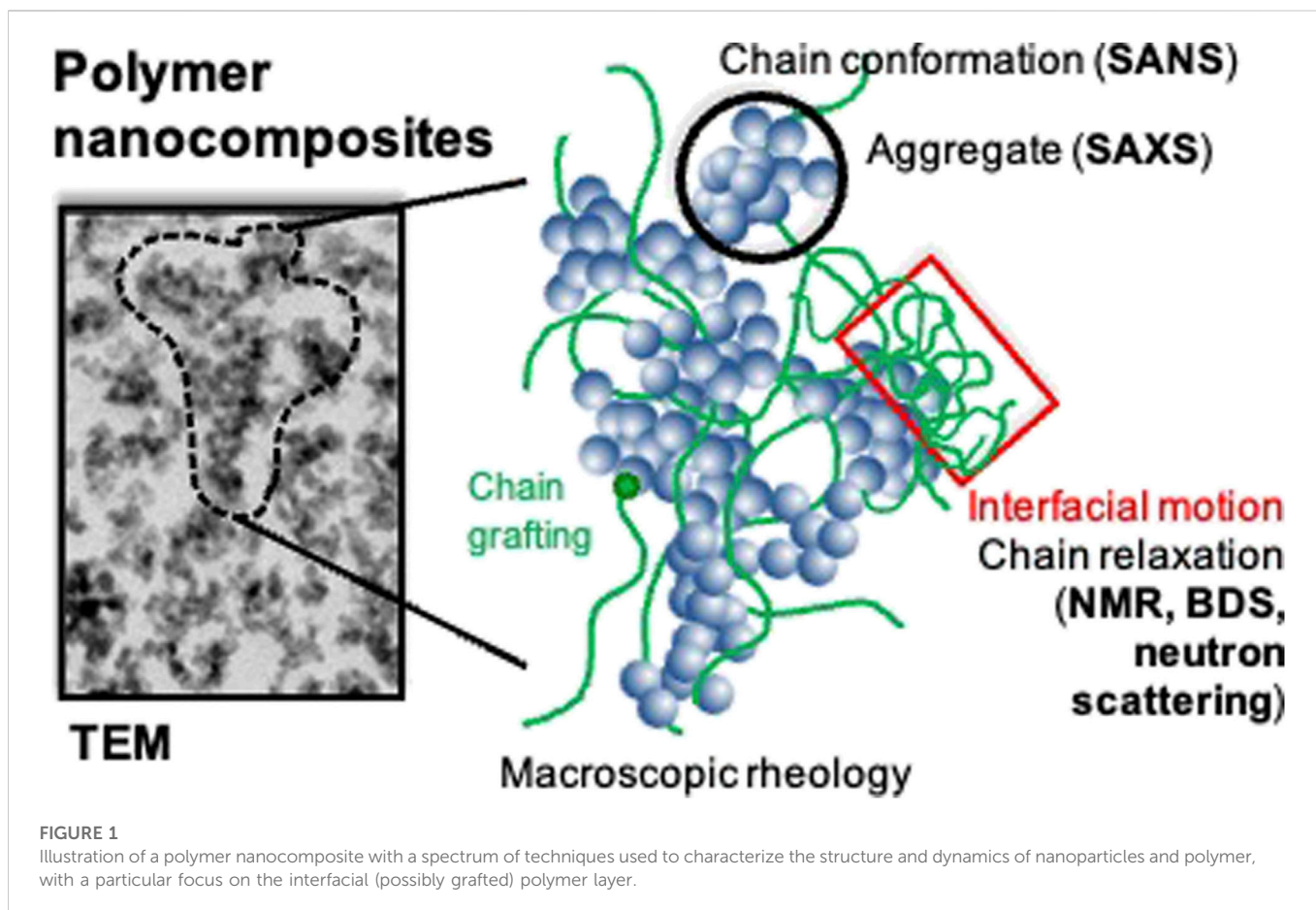
Editorial on the Research Topic

[Nanocomposites with interfaces controlled by grafted or adsorbed polymers](#)

Polymer nanocomposites represent an innovative class of materials used for a great variety of applications. They are formed by dispersions of typically hard inorganic filler nanoparticles in soft polymer matrices. A large range of polymer nanocomposites, based on particles of different size, shape and chemistry can be generated using various fabrication processes. A striking feature of nanocomposites is their large interfacial area that is determined, e.g., by nanofiller size and concentration, polymer-nanoparticle interaction, and the resulting dispersion of particles in the polymer matrix. The design of the nanofiller surface by grafting or adsorbing polymer molecules can modify both the interfacial physics and the filler structure, giving access to improved macroscopic (mechanical, electrical, or optical) material properties.

It is the aim of the present topical Research Topic to focus on some aspects of recent research in this highly active and evolving area. We review and summarize state-of-the-art investigations of polymer nanocomposite materials which promote at a better understanding and control of the complex behavior of nanocomposites. Two articles with original experimental approaches have been contributed, one presenting an innovative application of microgel-nanoparticle composites in solvent, the other an in-depth study of the structure and dynamics of a bulk polymer nanocomposite. In parallel, we have reviewed the general field of particle and polymer structure and dynamics using scattering techniques, in particular neutron scattering, and highlighted the role of interfacial polymer layers in the specific case of polymer-grafted nanoparticles in a second review.

Nanocomposites can have many faces and may serve for fundamental studies as well as applications. [Figure 1](#) illustrates the typical morphology of polymer nanocomposites, where possible length scales are set by the size of the primary particle, which is most often in the 20 nm range. Appropriate techniques for probing different aspects are mentioned in the legend. An original application oriented nanocomposite is described by [Sabadasch et al.](#) Catalytically active palladium nanoparticles are incorporated into the core of a polymer microgel, which is thus itself a nanocomposite made of two different polymers with a core-shell structure. A combination of light scattering to study the temperature-dependent size of the particles, and electron microscopy to localize the NPs, is proposed. The core-shell



structure is shown to provide superior properties by protecting the palladium catalyst, avoiding NP aggregation and loss, and making the system reusable.

The power of scattering techniques for the investigation of soft matter systems such as polymer nanocomposites is reviewed in the contribution of Kruteva et al. Contrast variation in neutron scattering allows highlighting different parts of nanoscopic objects, and spectroscopic scattering techniques such as neutron spin echo or backscattering spectroscopy match perfectly the length- and time-scales of molecular dynamics. Such measurements can be complemented by NMR and broadband dielectric spectroscopy, highlighting the contribution of chains at the nanoparticle interface. The full picture of nanoparticle arrangement within the polymer matrix, and the way the particles and the chains contribute to the dynamics and thus to macroscopic properties like flow can thus be assessed and possibly optimized.

Nanocomposites consisting of polymer chains and nanofillers inspired by tire rubber materials are presented in the contribution of Philippe et al. Rheological properties are put into relationship with the

relaxation spectra from dielectric spectroscopy and on molecular length scales to the relaxation times in neutron spin echo spectroscopy. The impact of filler concentration and temperature as two crucial parameters for rubber in application could be studied in this way, finding an unexpectedly high slow-down of segmental relaxation with the presence of NP interfaces. This molecular relaxation mechanisms could be related to macroscopic properties observed by rheology. Moreover, using a sophisticated deuteration scheme, these authors succeeded in measuring the single-chain structure factor in the bound polymer layer by small-angle neutron scattering.

Finally, hairy nanoparticles are introduced in the mini review by Sharma et al., and discussed in terms of their potential for designing materials with superior properties compared to simpler procedures such as simple mixing of components. Due to the possibility of having self-suspended nanocomposites where the grafted polymer is also the matrix (so-called one component nanocomposite—OCNC), the traditional formulation problems are automatically avoided, and the flow properties can be tuned. Grafting density, molecular

weight and grafting chemistry are some adjustable screws for novel materials with advanced mechanical properties.

We hope to provide a small but useful Research Topic of reviews and new research on different types of nanocomposite materials, with various applications such as catalysis or rubber technology, and with a Research Topic of thought-stimulating literature on scattering approaches and other experimental techniques to the study and analysis of polymer-based nanocomposite materials.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.