

SOFT MATTER

It's hard for soft matter to hide from neutrons

Oak Ridge National Laboratory (ORNL) is the US epicenter of neutron scattering, a powerful technique for studying the nature of soft matter in helping develop products such as medicines, plastics and composites, and paints and coatings.

Both scientists and non-scientists can access ORNL's research facilities via the US Dept. of Energy's User Program. ORNL's two world-leading, complementary neutron research user facilities — the **High Flux Isotope Reactor (HFIR)** and the **Spallation Neutron Source (SNS)** — are open to researchers to facilitate their studies in science and technology. Together, HFIR and SNS offer users 31 advanced instruments and their supporting laboratories to use for a wide range of materials research experiments.

"When ions move through batteries they are surrounded by other molecules. The performance of batteries depends on the time required for the surrounding molecules to diffuse away. We were able to measure this time scale, which was about one nanosecond, using quasielastic neutron scattering at ORNL."

Nitash P. Balsara
University of California, Berkeley
Photo credit: Rounak Jana



No neutron science experience is necessary

Oak Ridge National Laboratory's neutron science User Program invites you to collaborate with us, onsite or remotely, to achieve greater success. No neutron science experience is necessary, as our experts work closely with users to ensure the success and safety of their experiments. We can help you find the neutron techniques, instruments and sample environments best suited for your research.

Neutron users can access neutron facilities — at little or no cost

Beam time is granted through a proposal system managed by the User Program and is free of charge (with the exception of travel costs, if necessary) as long as researchers intend to publish their results to the scientific community. A fee is charged only for proprietary research that will not be made public.



Contact the Neutron Users Office

Web: neutrons.ornl.gov/users
Email: NeutronUsers@ornl.gov
Phone: 865-574-4600 or 865-341-4451

SOFT MATTER

Neutrons are ideal for studying soft matter

Each year, our neutrons help scientists gain a better understanding of the processes and properties of soft materials. From penetrating dense materials and probing light elements, to their neutral charge and magnetic moment, neutrons facilitate studies that are difficult or impossible with other research techniques. Neutron scattering techniques are often used to complement SAXS, spectroscopy and microscopy.

A variety of sample environments are available to support soft matter experiments, including temperature control, pressure cells, rheometers, tensile stages, humidity cells, tumblers and many more.

Selected neutron scattering applications for soft matter studies

- Drug delivery
- Manufacturing
- CO₂ capture
- Electrochemical devices
- Medical devices
- Industrial materials
- Catalysis
- Natural gas recovery
- Electronic devices

Examples of previous soft matter studies performed at SNS/HFIR

Polymers

- Quasielastic neutron scattering (QENS) revealed the properties of polyethyleneimine for CO₂ capture.
- Time-resolved small angle neutron scattering (SANS) provided molecular-level insight into the dynamics of chain exchange in concentrated triblock networks.

Surfactants

- Neutron imaging helped identify the effect surfactants have on natural gas recovery from shale.
- In situ SANS helped find the structures of surfactants in a bulk solution of firefighting foam with and without exposure to fuel.

Colloids

- A neutron total scattering study of the double-difference pair distribution function found very small structural differences in nanoparticle dispersions of iron oxide in deuterated water.
- SANS combined with rheometry helped identify a transient elasticity zone in a charge-stabilized colloidal glass under steady shear.

Gels

- Neutron reflectivity provided insight into how the structure of layers in deuterated hydrogel films changes via composition and thickness under various conditions for use in medical devices.
- Time-resolved SANS revealed how a supramolecular gel self-assembles to tune the growth process for different applications.

Glasses

- In situ inelastic neutron scattering revealed the changing vibrational entropy in metallic glasses by tracking the phonon contributions across the glass transition.
- Neutron imaging and SANS provided structural information about the effect of additives in borosilicate glass used to stabilize high-level radioactive liquid waste.

Nanocomposites

- SANS, neutron spin-echo, rheology and dielectric and spectroscopy were used to explain the viscoelastic properties and dynamic behavior of industrial polymer nanocomposites for use in tires.

Liquids

- QENS and inelastic neutron scattering revealed a microscopic picture of the proton conduction mechanism in a hybrid nanocomposite.
- The structure of ethaline, a potential catalysis material, was studied with neutron total scattering to understand its hydrogen bonding network.
- SANS revealed the temperature-dependent impact of ionic liquids on the self-assembly of a block copolymer as a function of concentration.

Membranes

- The overpotential limits of membranes for water electrolysis were discovered during neutron imaging.
- Neutron spin echo experiments investigated the molecular dynamics of unilamellar liposome membranes.