

Postdoctoral position at Université Pau & Pays de l'Adour, Anglet, France
**Experimental investigation on adsorption, deformation and transport couplings
in microporous materials
(NewPores project)**

NewPores International Hub presentation

NewPores is an international hub dedicated to the mechanics and physics of porous materials, which intends to answer to new Energy and Environment challenges. This is a joint effort of the group on Mechanics and Physics in Porous Media (MPPM) of the LFCR lab (UMR5150) at E2S UPPA (France), the Centre for Sustainable Engineering of Geological and Infrastructure Materials (SEGIM) at Northwestern University (USA), the University of Vigo (Spain), the Technical University of Madrid (Spain) and University of Liège (Belgium).

General context

Following the IUPAC recommendation, the pore space in porous materials is divided into three groups according to the pore size diameters: macropores of widths greater than 50nm, mesopores of widths between 2 and 50nm and micropores of widths less than 2nm. Zeolites, activated carbon, tight rocks, coal rocks, source rocks, clay, cementitious materials and biomaterials are among these materials. In recent years, a major attention has been paid on these microporous materials because the surface-to-volume ratio (i.e., the specific pore surface) increases with decreasing characteristic pore size. Consequently, these materials can trap an important quantity of fluid molecules as an adsorbed phase. This is important for applications in petroleum and oil recovery, gas storage, separation, catalysis or drug delivery.

For these microporous materials, a deviation from standard poromechanics is expected. In nanometer-scale pores, the molecules of fluid are confined. This effect, denoted as molecular packing, induces that fluid-fluid and fluid-solid interactions sum at the pore scale and have significant consequences at the macroscale, such as instantaneous deformation. A lot of natural and synthesised porous media are composed of a double porosity: the microporosity where the fluid is trapped as an adsorbed phase and a meso or a macro porosity required to ensure the transport of fluids to and from the smaller pores. If adsorption in nanopores induces instantaneous deformation at a higher scale, the matrix swelling may close the transport porosity, reducing the global permeability of the porous system or annihilating the functionality of synthesised materials.

Within the NewPores project, a new enhanced poromechanics framework has been proposed allowing the prediction of adsorption-induced deformation in micro and mesoporous materials but reliable experimental data are scarce to validate and discriminate such models. Recently a new protocol based on evaporation induced self-assembly method and dip-coating has been proposed within the team to synthesized mono and poly-disperse micro/mesoporous silica film with controlled characteristic, tailored pore size and structure. In situ vapor ellipsometry-based adsorption-induced deformation experiments may now be carried out to assess the proposed models in simple and controlled configurations.

In addition, it is still difficult to characterize experimentally the effect of the adsorption-induced deformation on the global transport properties of a double porosity medium. Classically, the experimental protocol to measure an intrinsic permeability consists in imposing an axial gas flow through a porous medium and in measuring the mass flow, the upstream pressure and the downstream pressures at a given confinement pressure. By using the Klinkenberg's law, the intrinsic permeability is then deduced. Therefore, the measurement may be considered as global and the intrinsic permeability is supposed to be constant all along the sample, leading to a linear gradient of the pressure. However, under swelling deformation, the local permeability may be impacted, and the pressure gradient may become non-linear. Consequently, it is not obvious to collect experimental data for model validation on the influence of adsorption on transport properties because we cannot measure easily the pressure evolution along the porous medium under swelling. This project aims also to collect new experimental data on adsorption-induced transport evolution on Zeolite Templated Carbons (ZTC) which are also synthesized and characterized within the group.

Partners

LFCR/MPPM group in Anglet, **IPREM** group in Pau, **LCMCP** group in Paris, **IC2MP** group in Poitiers.

Contact : David Grégoire / Laurent Perrier

UPPA - IPRA - LFCR

Campus Montaury – Côte Basque
64600 Anglet, France

[david.gregoire or laurent.perrier \[at\] univ-pau.fr](mailto:david.gregoire or laurent.perrier [at] univ-pau.fr)

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Postdoc candidate objectives

Within the *Newpores* project, the Postdoc candidate will be in charge of the experimental developments on two different aspects.

On one side, he will perform vapor ellipsometry-based adsorption-induced deformation experiments on silica film synthesized by evaporation induced self-assembly method and dip-coating. To build a complete database allowing model validation, he will also fully characterize the material in terms of porosimetry and mechanical properties, including micromechanics behavior.

On the other side, he will be in charge of the design of an experimental platform allowing the measurement of the local evolution of the pressure along a ZTC porous medium subjected to adsorption-induced deformation. Here also, the material will be first characterized in terms of porosimetry, mechanical properties, free adsorption-induced swelling behavior before being used in the new experimental platform allowing the measurement of the evolution of the local permeability upon adsorption and swelling.

Candidate's profile

The candidate should hold a PhD degree in experimental physics, experimental mechanics, material sciences or a similar field. Note that the candidate could be in the process of obtaining his PhD degree during the application process, but the PhD defense must have occurred before the actual starting date of the postdoc position. Previous experience with lab testing development is mandatory. Previous experience with the characterization of multi-physics couplings appearing in porous media is an asset as well as a real working autonomy. The candidate should have a strong interest in working in a multi-disciplinary team. Proficiency in English (B2 minimum) is mandatory for both oral and writing communication. Effective scientific article writing skills will be an asset.

Job details

The successful candidate will be hosted by LFCR (UMR5150, UPPA-CNRS) in Anglet, France and he will be supervised by David Grégoire and Laurent Perrier. Temporary hosting within the LCMCP group in Paris will be mandatory to perform vapor ellipsometry-based experiments. Temporary hosting within the IPREM group in Pau or the IC2MP group in Poitiers may be necessary for synthesis purposes (synthesis protocols are already perfectly mastered). The envisioned starting date is January 6th, 2025, and the contract will necessarily end on December 31st, 2025. The position includes full social security coverage and a gross salary of approx. 3000 € per month.

Evaluation procedure

Candidates will be ranked in a first phase based on their submitted application.

In a second phase, a visioconference interview will be organized with the pre-selected candidates.

Applications should include a cover letter, CV, passport/ID copy, transcripts of diplomas and lists of courses attended (with grades obtained), recommendation letters, and names and contact details of at least two references.

Applications should be submitted from October 1st, 2024 at www.davidgregoire.fr/opening-positions.

Application deadline: October 31th, 2024, 23:59 CET.

Interviews for selected candidates will take place in November, 2024.

Final answer will be provided by December 2nd, 2024.

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