

Carbon Capture, Utilisation and Storage:
Opportunities, challenges and pathways to Net Zero
Thematic workshop - 17th September 2026 - Faculty of Civil and Industrial Engineering,
Sapienza University of Rome

ECCSELLENT Project towards Net-Zero emission: A novel Laboratory for gas sorption, diffusion and transport in polymers for Advanced CCUS Research

Di Carlo R., Maghazeh Z., Signorini V., Minelli M., Giacinti Baschetti M.*

1 - Department of Civil, Chemical, Environmental and Material Engineering (DICAM), University of Bologna, Bologna, Italy

* Corresponding author: marco.giacinti@unibo.it

The rapid growth of anthropogenic activities and industrialization has led to a significant increase in the concentration of greenhouse gases in the atmosphere, thereby contributing to global warming [1]. In this context, Carbon Capture and Storage (CCS) has emerged as a crucial technology for reducing atmospheric CO₂ levels, supporting the achievement of net-zero emissions targets, and mitigating climate change [2].

As part of the ECCSELLENT project, Alma Mater Studiorum - Università di Bologna (UniBo) is committed to enhance its CCUS research infrastructure shared within the Italian Node of ECCSEL framework [3], with particular focus on the development and characterization of polymeric materials for use as membranes in carbon capture processes and as liners or gaskets for CO₂ transport. Polymers, thanks to their lightweight nature, adaptability, and chemical resistance, are today leading the market of gas separation membranes and results ideal for handling extreme conditions of pressure and temperature typical of CO₂ transport chains, essential for controlling leakage and failure.

In order to expand the knowledge of CO₂ capture and transport, the new research center focuses on the preparation and characterization of innovative polymeric samples via chemical, mechanical and physical analysis. The main approach is related to the investigation of gas solubility, diffusivity, permeability, as well as selectivity in polymer and polymer-based materials.

In particular, polymeric membranes for CO₂ capture can be developed in various forms, including self-standing films, thin coating or hollow fibers. The manufactured polymers can be characterized by using QCM-D and AFM to measure thickness of the active layer, morphology and surface topography. In addition, the gas separation efficiency, Solubility, Diffusion and Permeability coefficients are determined through single and mixed gas permeation experiments, working either in dry or humid conditions.

In parallel, polymers are investigated as potential liners and sealants for CO₂ transport. Their sorption and permeation behavior under high-pressure and low-temperature conditions is assessed using dedicated instrumentation and custom-built permeation rigs. The effects of dense-phase CO₂ exposure on the chemical, structural, and mechanical properties of the materials are monitored during and after exposure using IR and dielectric spectroscopy.

Keywords: CCS, membranes, CO₂ transport

Organized by

**Carbon Capture, Utilisation and Storage:
Opportunities, challenges and pathways to Net Zero**

Thematic workshop - 17th September 2026 - Faculty of Civil and Industrial Engineering,
Sapienza University of Rome

Acknowledgments

National Recovery and Resilience Plan, Mission 4 Component 2 Investment 3.1 “Fund for the realisation of an integrated system of research and innovation infrastructures”- Call for tender 3264 (28 Dec. 2021) of the Italian Ministry of University and Research funded by the European Union—NextGenerationEU—PNRR IR0000020, Concession Decree 244 (8 Aug. 2022) adopted by the Italian Ministry of University and Research, CUP F53C22000560006, ECCSELLENT—Development of ECCSEL-R.I. Italian facilities: user access, services and long-term sustainability.

References

- [1] Lindsey, R. Climate Change: Atmospheric Carbon Dioxide | NOAA Climate.Gov Available online: <https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide> (accessed on 5 September 2024).
- [2] Herzog, H. Carbon Dioxide Capture and Storage. In The Economics and Politics of Climate Change; 2015 ISBN 9780191808616.
- [3] <https://www.eccsel.eu> – last accessed: September 2026

Organized by