Enhancing Italian Research Infrastructure for CO_2 Capture and Transport: Contributions from the ECCSELLENT Project

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Carbon capture, utilization, transport, and storage (CCUS) has emerged as a vital strategy to mitigate climate change and support the transition to net-zero emissions. Within this context, the ECCSELLENT project—part of the ECCSEL ERIC framework—aims to upgrade key Italian research facilities and expand the national network for CCUS, covering the entire chain from capture to storage. As part of this project, the Department of Civil, Chemical, Environmental, and Materials Engineering (DICAM) at the University of Bologna is enhancing its infrastructure to support CO_2 capture via membrane processes and to address challenges related to CO_2 transport.

The upgraded infrastructure will enable the development and testing of innovative polymeric membranes for CO_2 separation. These membranes, fabricated as flat sheets or hollow fibers using spinneret machines and coating systems, are being comprehensively characterized to evaluate their chemical, mechanical, and transport properties. Advanced techniques such as FTIR, QCM-D, and AFM are employed to investigate nanoscale interactions and surface morphology. Gas separation performance will be assessed through single and mixed-gas permeation experiments under both dry and humid conditions, enabling the determination of permeability, diffusivity, and solubility.

The project will also examine polymer sorption behavior under high-pressure and low-temperature conditions—typical of CO_2 transport—using BET analysis and explore the dielectric response of materials exposed to dense-phase CO_2.

This integrated approach will advance the understanding of gas–polymer interactions in operational environments and support the development of efficient, scalable technologies for CCUS applications.

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