Thesis Proposal for the Master's Degree in Physics
Gruppo "Superfici e Energia"
Ref. Prof. Raffaele G. Agostino

The Surface and Energy research group at the University of Calabria, led by Raffaele G. Agostino, focuses on studying materials with innovative chemical-physical properties for both fundamental and applied purposes, such as energy and electronics. The team, consisting of researchers and collaborators, utilizes **advanced spectroscopic and microscopic techniques** (HREELS, XPS, UPS, SEM, etc.) to characterize surfaces and interfaces. Currently, they are involved in building the **STAR X-ray source** for advanced microtomography and spectroscopy studies. Their main research areas include gas adsorption in nanostructured materials, the characterization of self-assembled molecular layers, the analysis of two-dimensional systems like graphene, and the development of advanced tomographic imaging techniques. Additionally, the group contributes to the **DeltaH laboratory** for hydrogen storage solutions and conducts pioneering research in **virtual histology** using **artificial intelligence** techniques for tissue analysis.

Title:
Optimization of Zeolite-Templated Carbon (ZTC) for Enhanced CO_2 Capture: Synthesis, Characterization, and Surface Functionalization

Abstract:
This thesis investigates Zeolite-Template-Carbon (ZTC) materials synthesized using beta-type zeolite templates for CO_2 capture applications. We developed and characterized ZTC samples through a series of post-synthesis surface modifications aimed at tuning the carbon-oxygen functional groups on pore walls to enhance CO_2 adsorption. Structural and morphological analysis was performed using X-ray diffraction (XRD), Raman/FT-IR spectroscopy, and scanning electron microscopy, while gas adsorption properties were measured with Sievert's-type apparatus. Findings reveal that optimized micropore size distribution, high specific surface area, and tailored surface functionalities significantly improved CO_2 uptake, achieving a reversible adsorption capacity of 76.5 wt% at ambient conditions. Enhanced structural ordering and the effect of oxygen functional groups on adsorption efficiency were explored through Raman spectroscopy, providing insights into the influence of post-synthesis treatments on ZTC's porous architecture and CO_2 capture performance.

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Laboratory where the thesis is carried out:
Surface and Energy Lab in collaboration with the Chemical Engineering, Catalysis and Sustainable Processes Laboratory, University of Calabria

Type of thesis:
Experimental and data analysis