# PhD in Materials Science and Technology

## Research Title: Carbon functional materials from biowastes

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| **Funded by** | Fondazione Istituto Italiano di Tecnologia |

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| **Supervisor** | Prof. Claudio Gerbaldi<br>(Prof. Guido Saracco per IIT) |

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| **Contact** | https://www.iit.it/centers/csf-polito-torino |

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| **Context of the research activity** | In a circular economy perspective, processes that can transform biowastes into activated carbon materials are of high importance. In turn, these activated carbons can be employed for separation processes (e.g., biogas purification to biomethane) or as catalyst supports (e.g., bio-oil hydrotreating) as well as electrode/electrolyte components in electrochemical energy storage/conversion devices, which are essential in many processes targeting sustainability in the present energy scenario.<br>Starting from organic solid wastes, various potential carbon material precursor (e.g. ligno-cellulose, poultry wastes, polysaccharides, monosaccharides, paper wastes, etc.) can be identified.<br>Different techniques ranging from pyrolysis to low temperature processing such as sol-gel, hydrothermal and microwave-assisted synthesis, can be used to obtain char or carbonaceous precursor gels. Afterwards, these intermediates can be transformed into carbons using different approaches, depending on the final destination of the material. For example, gels can be shaped as aerogels, nanofibers or micro and nanoparticles prior to a final pyrolysis under inert gases. Conversely, char can be activated with $CO_2$ or steam to produce activated carbon and syngases suitable for downstream synthesis of methanol, DME or other fuels. |

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| **Objectives** | The objectives of this PhD are:<br>- Characterization of a span of organic precursors derived from solid wastes.<br>- Comparison of their properties to those of commercially available “standard” precursors (e.g. agar, glucose, cellulose, lignocellulose, chitosan, etc.) |

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| | - GEL ROUTE:<br>  - Synthesis, optimization and characterization of gels prepared from both solid waste organic precursors and commercial ones.<br>  - Preparation of different types of materials using different approaches such as aerogel or nanofiber synthesis<br>  - Carbonization and activation of the carbon materials.<br><br>- PYROLYSIS/$CO_2$-STEAM ACTIVATION ROUTE:<br>  - Synthesis, optimization and characterization of carbons by direct pyrolysis of wastes<br>  - Activation by high-temperature $CO_2$ or steam treatment<br><br>- CHARACTERISATION & TESTING<br>  - Characterization of the synthesized materials and optimization of their properties.<br>  - Characterization and optimization of the activated carbons.<br>  - Test of the synthesized materials in a lab-scale reactor to evaluate their performance as gas separation media and catalyst supports for the selected reactions in the circular economy arena.<br>  - Assembly of the synthesized materials in next-generation energy storage and conversion devices and their characterization as both electrodes and/or electrolyte components in terms of electrochemical performance, compatibility and stability.<br>  - Modelling of the above processes |

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| **Skills and competencies for the development of the activity** | A skill in chemistry and/or materials preparation is considered important.<br>A good knowledge of common practices in chemical laboratories are also desirable.<br>A background in characterization techniques and modeling functional materials is also welcome. |