

## Brief description of the training project (1)

### ❖ Title of the Training Project:

Electrocatalytic synthesis of olefins from CO<sub>2</sub>

### ❖ Description of the scientific and educational objectives:

The direct electrocatalytic synthesis of light olefins from CO<sub>2</sub>, H<sub>2</sub>O and renewable energy represents one of the new research directions for the production of raw materials for the chemical industry with an ultra-low, and potentially negative carbon footprint as a function of the optimization of the process and the source of energy. renewable. The use of CO<sub>2</sub> as a carbon source involves not only its reuse and closure of the carbon cycle but transforms waste into a product with a high added value that reduces dependence on fossil fuels, thus allowing greater industrial resilience and integration with the territory, in addition to representing a strong element of innovation in the industrial sector that must face the challenge of developing the technologies necessary for the goal set for net-zero emissions (of greenhouse gases) for 2050.

The topic addressed will therefore allow the creation of a highly qualified figure, on the issues of i) development of innovative electrocatalytic processes, ii) closure of the carbon cycle, iii) preparation and testing of electrocatalysts, iv) mechanisms of activation and selective reduction of CO<sub>2</sub>, v) advanced characterization of electrocatalytic materials, vi) devices and cells for the study of electrocatalytic processes and their engineering.

The study provides for the multidisciplinary integration of various skills, focused on industrial chemistry, but which extends from the study of the physics and chemistry of materials and their characterization to the engineering of devices and industrial development. The proposed study is therefore perfectly consistent with the themes of the ACCESS PhD which is centred on the development of innovative solutions for industries that use renewable energy to convert molecules such as CO<sub>2</sub> and produce fuels or chemicals by replacing the current methodologies that use fossil fuels.

The proposed research is fully consistent with the needs of the country, in terms of i) reduction of dependence on fossil fuels and ii) greenhouse gas emissions, iii) promotion of the use of renewable energy, iv) increase of the innovative capacity and the competitiveness of industry, v) promotion of human capital. It is also fully consistent with the territories involved in the program (Sicily), as there is a) the promotion of human capital, b) the development of the renewable energy chain, c) the reduction of greenhouse gas emissions and d) the development of innovative solutions for closing the carbon cycle in energy-intensive industries.

The technologies developed will allow an increase in the resilience of the territory and represent new innovative possibilities for the development of sustainable and integrated chemistry with the territory, which also represents an industrial recovery plan for the crisis areas present in the region following the closure of many production lines in the chemical area.

### ❖ Company Supervisor: Dr. Angelo Ferrando (Versalis spa)

### ❖ Methods of carrying out training and research activities:

The training and research activities will be integrated into the context of the ACCESS International and Industrial Doctorate which provides for a series of training and educational

activities, which are coherently integrated with the proposed research activity. The interaction with other PhD students, the possibility of interaction and collaboration with other national and international PhD students, the training activities (from seminars to schools and meetings) and the additional skills that are provided (from training to work in the industrial sector, to aspects of confidentiality and patents, to the increase of computer and linguistic skills, as well as to work in teams) are an added value compared to the typical training in Doctorates. The additional added value is represented by a period, from 6 to 12 months, at Versalis to further increase the ability to operate in the field of industrial development.

The research activity, apart from the period at Versalis, will be carried out at the CASPE Laboratory (Catalysis for Sustainable Production and Energy) of the University of Messina which has over twenty years of experience in the issues of electrocatalysis in the conversion of CO<sub>2</sub> and has both the that of the staff and equipment that allow the PhD student to operate with maximum efficiency in achieving the aims of the project.

The study will address the various elements necessary for complete training of the PhD student, from the preparation of the catalysts and other necessary materials to their characterization using a combination of experimental techniques, to the study of their behaviour, and to the development of the reactors and devices necessary for the study, including aspects of scale-up and industrial development, depending on the results obtained.

❖ **Effects and expected results with particular emphasis on promoting economic development and the production system:**

The study combines both fundamental and applicative aspects, as the goal is the development of technology applicable from an industrial point of view, with therefore considerable attention to all aspects that allow a quick transition from laboratory results to industrial application.

The expected results are the development of knowledge for a new technology of direct electrocatalytic production of olefins from CO<sub>2</sub> using renewable energy, which will allow the evaluation of the development of a new process that replaces the current one starting from fossil fuels, after the further necessary stages of study at higher TRL.

The results, therefore, represent the first element in the development of a new olefin production technology to arrive at a new process for the production of basic materials from the chemical industry starting from CO<sub>2</sub> and renewable energy, which therefore allows reaching the mitigation objectives. climate change and innovation at the basis of the PNRR and economic development and the production system.

**Company name:** Versalis S.p.A.

**Website:** <https://versalis.eni.com>

**Country:** Italy

The aforementioned company will host the PhD student beneficiary of the scholarship financed on the resources of Ministerial Decree 352/2022 for a period of 6 months during the course of the doctorate.

Period abroad for a period of 6 months at the following institution:

Helmholtz-Zentrum Berlin (CatLab) and Fritz Haber Institute (MPG) in Berlin (Germany)