**Research Group Description**

[Energy Conversion and Storage Web page](https://itqmembranes.itq.webs.upv.es/)

The **ECS** research group has a high degree of multidisciplinarity. Its work is focused on developing new solutions that contribute to reducing greenhouse gas emissions, increasing efficiency and decarbonization in the production of energy and chemical products of industrial interest. The group's activities to achieve these goals include the fundamental study of functional materials and chemical processes and developing devices and technologies with a clear industrial orientation. The main work disciplines of the group are:

1. Development of fuel cells and electrolyzers for operation generally above 250 °C.
2. Catalytic conversion for energy processes, including partial oxidation of hydrocarbons, synthesis or electro-synthesis of different fuels and intermediate reactions such as water displacement in a wide range of temperatures.
3. Development of processes for revalorizing wastes, mainly from biomass and waste resources, to produce value-added products and fuels and commodities (industrial chemicals).
4. H2 production, generally through the design of catalysts and integrated reforming processes of fossil and renewable origin molecules, such as natural gas, green methane, light olefins, green alcohols, etc.
5. Development of gas separation membranes (H2, O2, H2O and CO2) for their integration in high-temperature thermal processes.
6. Development of catalytic membrane reactors and other solid-state ionic devices.
7. Development of multiphysics models of high complexity that are of great industrial utility.
8. Development of complete chemical plant/process models to perform techno-economic studies and identify the optimal and safest operating conditions.

In the field of catalytic process intensification research, it is worth highlighting that the group has achieved milestones of great relevance, such as (a) the development of a co-ionic membrane reactor for the direct conversion of natural gas into aromatic products, published in Science in 2016 and (b) the one-step production of compressed hydrogen from electricity and methane with very high energy efficiency, recently published in Nature Energy.

**The members of the ECS group are:**

* Prof. José Manuel Serra Alfaro, h-index 45 (source Scopus)
* Dra. Sonia Escolástico, h-index 22
* Dr. Antonio Chica Lara, h-index 27

The trajectory and **scientific achievements of the ECS group** can be supported by the different scientific publications and outstanding transfer activities it carries out. The group **has published an average of 28 scientific articles per year in the highest impact journals** in its field, and in the best international scientific journals such as *Science*, *Nature Energy*, *Nature Scientific Reports*, *Energy & Environmental Science* or *Advanced Energy Materials*. A significant percentage of the publications (>50%) are made in collaboration with prestigious international centers such as: University of Oslo, Research Center Jülich, University of Twente, CNR, CNRS, Kalrsruhe Institute of Technology, Coorstek Membrane Sciences, University of Bologna, University of Ghent, Max-Plank Berlin, University of Oklahoma, Colorado School of Mines, etc. Strong collaboration with these centers has resulted in excellent scientific work and joint European or industrial projects.

Furthermore, **the group has an outstanding activity in knowledge transfer to industry, as evidenced by the 46 patents filed (most of them transferred), the 17 research contracts with companies during the last 5 years and the creation of a spin-off company (Kerionics)** for the exploitation of patents related to industrial modules for hydrogen and oxygen production. This activity has been recently recognized since the **research group within the CSIC has the qualification of A (Excellent) which is to say it is among the 5% best groups in the area of chemistry and technology at the national level**. The group is developing technological decarbonization solutions for global industrial partners such as ExxonMobil, Air Liquide, Total Energies, Tecnicas Reunidas, ACS Industrial, SENER, etc.

The group's PIs have received awards from different entities, both international (Air Liquide - 2019, European Ceramic Society - 2015) and national (Real Sociedad Española de Ingeniería - 2016).

**Brief description of the CVs of each of the researchers of the ECS group**

*Prof. José M. Serra*: He was born in Valencia in 1976. He did his Ph.D. Thesis at Instituto de Tecnología Química (ITQ) under the direction of Prof. A. Corma, financed and in collaboration with the Institute Français du Petrole (France). The thesis focused on developing new tools for combinatorial catalysis and their application in obtaining and optimizing new industrial catalysts. He spent a two-year post-doctoral stay at the Institute for Energy and Climate Research (IEK-1) at the Forschungszentrum Jülich, Germany, working on the development of SOFC nanostructured cathodes as well as ion conducting membranes in Prof. D. Stöver's group. In 2006 he returned to ITQ, where he is currently in charge of the research line on fuel cells and ion conducting membranes. In 2012 he was promoted to Research Scientist and in 2015 promoted to Research Professor. His scientific activity is mainly focused on the application of catalysis and materials science to the: a) development of components for solid oxide fuel cells (SOFC) and electrolyzers (SOEC), with special attention to the design and characterization of new electrocatalysts (mainly cathode materials) and proton and ionic conduction electrolytes; b) development of mixed ion-electron conducting membranes for oxygen and hydrogen separation and for application in catalytic membrane reactors; and c) development of new intensified processes. As a result of his work, Jose M. Serra is co-author of more than 200 articles, 18 books/book chapters and 30 patents in the field of catalysis and energy and has participated or participates (as CSIC PI) in 16 European FP7, H2020 and Horizon Europe projects related to ionic membranes, electrolysis, proton-conducting reactors and process intensification: EFFIPRO, NASA-OTM, DEMOYS, GREEN-CC, ELECTRA, GAMER, eCOCO2, WINNER, , CO2SMOS, SYMSITES, AMBHER, ALL IN ZERO, PROTOSTACK. His career has a strong international character, maintaining very active collaborations with many centers, being especially remarkable in his connection with centers of excellence in Germany, Norway and Australia. He is also the national representative of CSIC in the Advanced Materials Program (JP) of the European Energy Research Alliance and coordinator of the Materials for Energy program. He has supervised thirteen doctoral theses (two with special mention) and is currently supervising fifteen more. Founder of the spin-off company (EBT) KERIONICS SL that develops and commercializes gas separation membranes, mainly for hydrogen and oxygen production integrated into industrial processes. His main research lines are Intensification of catalytic processes; Capture and use of CO2; Energy efficiency; Solid oxide cells (SOC); green hydrogen and electrochemical reactors: electrocatalysis Ionic membranes, solid state electrochemical devices, and catalytic membrane reactors; Combinatorial and catalysis: design and development of high-performance processes and equipment; Heterogeneous catalysis: acid-base, red-ox and multifunctional catalysts; Synthesis and characterization of ceramic materials, including mesoporous; Chemical reactor and process engineering: design and tuning of chemical reactors and other small-scale devices and pilot plants.

Other PI’s merits are the **ExxonMobil** Chemical European Science and Engineering Award in 2005, the "Christian Friedrich Schönbein Contribution to Science Medal" awarded by the **European Fuel Cell Forum** (Luzern, Switzerland, 2009), the **European Ceramic Society** Young Scientist Award (2015), the **Royal Academy** of Engineering Medal (2016) and the **Air-Liquide Award** “Grand Challenge: Low-CO2 H2” in 2019. In 2022, he was appointed Director of ITQ.

*Dra. Sonia Escolástico:* She was born in Valencia in 1981. She completed her Ph.D. thesis in 2013, which was mainly focused on the synthesis, structural and electrochemical characterization, and hydrogen permeation measurements of mixed proton-electronic conductors resulting in 14 indexed publications, more than 30 conference contributions and one patent. After finishing her Ph.D., she continued her research activities at Instituto de Tecnología Química (ITQ) from 2007-2015. During this period, she participated in the study and development of materials, electrolyzers, and catalytic membrane reactors (CMR) for process intensification, resulting in 5 publications. It should be noted that 3 of these papers were published in very high impact journals: (a) 2 papers were published in "Energy and Environmental Science", describing two of the highest H2 permeations obtained so far with ceramic membranes, and (b) a third paper, describing a novel ceramic membrane for the direct non-oxidative conversion of methane to benzene, was published in "Science". In addition, one patent was licensed with Protia AG (CoorsTek Membrane Science). Also, during this time at ITQ, she participated in 3 European, two national and 2 German projects. In October 2015 she moved to the Institute for MicroProcess Engineering (IMVT) belonging to the Karlsruhe Institute of Technology (KIT), in Germany. Her research was based on the design and set-up of a compact metallic reactor to integrate ceramic membranes and realize oxygen permeation measurements in this reactor. In parallel, she studied protonic materials' structural stability and transport properties under severe reaction atmospheres. This research resulted in 2 publications and 8 conference contributions. In 2017, she joined ITQ again, focusing her research on developing different types of membranes, ceramic and metallic Pd and polymeric membranes, and their integration and testing in catalytic membrane reactors. From January 2018 to July 2020, she enjoyed a Juan de la Cierva Incorporation grant. Currently, she is a Senior Scientist at ITQ. One of her main research lines is the intensification of processes for converting CO2 into chemicals and fuels. She has co-authored 48 peer-reviewed contributions in international journals and participated in more than 100 international and national conferences, and European research projects, including industry contracts.

*Dr. Antonio Chica Lara:* Born in Fuensanta (Jaén) in 1969, he graduated in Chemical Sciences from the University of Granada (1987-1992) and received his Ph.D. from the Universitat Politècnica de València in 2002 (Extraordinary Thesis Award UPV-2002). He was a Fulbright postdoctoral fellow (2002-2004) in the Department of Chemical Engineering at the University of California at Berkeley (USA), was hired under the Ramón y Cajal program (September 2004-June 2007) and is a CSIC Senior Scientist and Associate Professor at the UPV (Dept. of Chemical and Nuclear Engineering) since June 2007. His research includes the study and development of new catalysts applied to the isomerization of both light and long chain kerosenes, the removal of sulfur compounds from fuels, and the development of new materials for sustainable energy production (e.g., hydrogen). He has also studied catalytic reforming, dehydrocyclization, alkylation and cracking reactions. His recent work includes applying High-throughput Techniques in preparing and testing catalysts for sulfur removal from fuels (liquid and gaseous) and hydrogen production from biomass-derived compounds. He also dedicates part of his work to the development of industrial processes for the production of energy through the integral use of waste streams. He has participated in 21 research contracts (in 9 as PI) funded by companies such as Exxon-Mobil, Johnson Matthey, Repsol-YPF, UOP, ENI, IFP, BP, CEPSA and Técnicas Reunidas. He has participated in 32 research projects funded by public entities (18 as PI, of which 4 are European). He has published around 47 articles in prestigious international journals (including two book chapters) and is co-author of 31 world patents, 24 of which were transferred to the industry and three in industrial exploitation. He is a representative of CSIC in the JP Fuel Cell & Hydrogen EERA in the line of Hydrogen Production, a member of the Spanish Society of Catalysis (SECAT), Royal Spanish Society of Chemistry (RSEQ), American Chemical Society (ACS), Spanish Hydrogen Association (AeH2), Spanish Platform of Hydrogen, Fuel Cells (PEHPC), Spanish Platform of Sustainable Chemistry and the International Energy Agency (IEA) task 16-Hydrogen Production from Biomass. Other merits of Antonio are the Extraordinary Thesis Prize UPV-2002, and the First Prize Valencia Idea 2009 (Energy and Environment).