Supervisor Profile:

Name and Surname: **RAYEES AHMAD RATHER**
Position: **SENIOR RESEARCHER, Photo(electro)catalysis for synthetic fuels and chemicals**
Department/Unit/Centre: **Hydrogen and Power to X Department**

a**) Describe your qualifications and experience. Provide information regarding your level of experience on the research topic proposed and your track record of work (e.g., papers, projects, main international collaborations, patent etc.), highlighting which scientific, technical and soft skills you will transfer to the candidate during the implementation of the research project.**

Rayees Ahmad Rather is currently a Senior Researcher in Photo(electro)catalysis for synthetic fuels and chemicals at CIIAE, Spain. Holding PhD in Chemistry with research dissertation on plasmonic excited nanocatalysts for solar driven water splitting and over a decade of research experience across different area of fundamental and applied photo(electro)catalysis. He has a strong international track record through postdoctoral trainings at the Hong Kong University of Science and Technology (2017–2019), Shenzhen University, China (2019–2021), Auburn University, USA (2022), and San Diego State University, USA (2023), before taking up his current group leadership role in Spain in 2024. His authorship in high impact journals covers the full pipeline from photoactive nanomaterial design, advanced characterisation and applied solar fuel production via nitrogen fixation, CO_2 conversion, hydrogen production, PFAS remediation and pollutant decontamination. His work is supported by his participation in research teams of international funded projects from USA (NSF, SERDP) and Science and technology and innovation commission of Shenzhen, China. Rayees has delivered invited lectures and talks across different countries such as Spain, Portugal, United States, Hong Kong and India and also served the editorial and reviewer responsibilities of different funding and publication agencies.

Rayees has a potential capability to transfer a comprehensive set of skills including scientific, technical and soft skills to potential MSCA candidate. The scientific skills include,

1. The design, synthesis, and characterisation of advanced nanomaterials including both conventional non-conventional materials. Band gap engineering and heterointerface design.
2. Development of out of box strategies to tackle charge transport and reaction selectivity, the decades old limitations of photocatalysis field. The strategies include the design and development of advanced chiral photocatalysts.
3. Electrochemical and photo(electro)chemical characterisation including the EIS, LSV, CV and operando spectroscopy.
4. Solid gas phase photothermal reactor, and PEC cells design for N_2 and CO_2 conversion to valuable chemicals and mechanistic investigation of the conversion processes.
5. Fundamental to scalable photo(electro)catalytic testing for hydrogen production from water and biomass.

The technical and soft skills include the scientific communications, result dissemination, experimental design, data analysis and grant writing skills.

b. Show your level of experience in supervising/training students and researchers, especially at advanced levels (i.e., PhD and postdoctoral researchers).

Rayees initiated a new research line in 2024 focused on Photo(electro)catalysis for producing synthetic fuels and chemicals at CIIAE in Caceres, Spain. At present, he is supervising one Ph.D. student enrolled at the University of Extremadura in Badajoz (UeX) in collaboration with CIIAE, engaged in activities such as designing and developing advanced optically active materials for solar driven water splitting reaction. Other supervising experience include a Postdoc (2024-2025) at CIIAE, working on development of advanced high entropy metal oxides and layered double hydroxides for photoelectrochemical conversion of CO_2 to C_2 products. Previously, as a postdoctoral/research fellow, Rayees participated in various research teams across multiple countries, including the United States, China, and Hong Kong, resulting in opportunities to supervise several master's and doctoral candidates with their thesis projects. Rayees have been actively involved in writing proposals, overseeing group activities, and drafting research report documents, developing leadership skills and adopt an independent approach to research tasks. During postdoctoral research training, Rayees contributed to various successful projects funded by different government agencies, such as,

1. A "concentrate-and-destroy" technology for treating per- and polyfluoroalkyl substances using a new class of adsorptive photocatalysts funded by National Science Foundation (NSF, Grant CBET-2041060), United States of America.

2. A 'Trap-and-Zap' Technology for Cost-Effective Removal and Destruction of Aqueous Phase Per-and Polyfluoroalkyl Substances at DoD Sites (Grant ER19-SO-14422), funded by SERDP ESTCP, United States of America (USA).

3. High Valence Ni based oxides for electrocatalytic urea decomposition towards H2 synthesis (Fundamental Research Project of Shenzhen, Grant, JCY120190808141015383), Science Technology and Innovation Commission, Shenzhen Municipality, Shenzhen, China.

Rayees supervised and mentored four master's students with their thesis work, resulting in at least two well-regarded publications. To advance as an independent researcher, educator, and leader, Rayees have pursued various personal development courses to enhance his societal and academic understanding. For instance, successfully completed a one-year bachelor's in education (B. Ed) program at Kashmir University (2012), India, to grasp the fundamentals of teaching philosophy, psychological behaviours, and effective teaching practices. Also completed several online courses, including a certification on unconscious bias for employees, which is vital for paper and grant reviewing as well as in the broader academic context. Additional courses have covered topics such as laboratory management and waste disposal.

What we offer (Research support):

Research facilities:

At CIIAE we offer comprehensive support across the full cycle of advanced materials research, from synthesis to application. We specialize in a wide range of material fabrication techniques including wet synthesis, hydrothermal, solvothermal, sol-gel, and template-based methods with particular expertise in high entropy materials, carbonitrides, plasmonic MXenes, and quantum dot architectures. Our state-of-the-art characterization capabilities span optical, morphological,

structural, and electrochemical analysis, utilizing instruments such as XRD, RAMAN/FTIR (OPERANDO), SEM, TEM, NMR, EPR, UV-Vis/DLS spectrometers, Spray coaters, GC, GC-MS, ICPMS, and solar simulators, among others. On the application side, we focus on critical clean energy and environmental challenges, including H_2 production from water and biomass through advances quartz (colloidal) and PEC reactors, CO_2 capture and conversion, N_2 fixation, CO_2/N_2 coupling, through PEC and solid gas phase method (500 mm, solid gas phase quartz reactor) and PFAS remediation. Our laboratory infrastructure supports work from fundamental research (TRL 0–4) through to photothermal and photoelectrochemical systems (TRL 3–6), with a clear roadmap toward scalable reactor deployment for green hydrogen production targeted for 2027–2028. Whether at the discovery, optimization, or scale-up stage, we are equipped to provide robust and multidisciplinary research collaboration.

Networking possibilities & external relations:

We are engaged and actively seek partnerships to foster the research goals and achieve the set TRL targets in our research line. Collaborative partnerships with academic institutions, research centres, industries stakeholders are our utmost priority to accelerate the translation of photo(electro)catalytic processes from fundamental into applied environmental solutions. We are trying to invest in cross disciplinary networks from material science, electrochemistry, photochemistry, and chemical engineering fostering knowledge exchange and joint research ventures with partners across Europe.

Project idea/position (scientific requirements, topic, discipline):

Currently seeking a potential candidate for MSCA 2026, who shares our research interests, particularly in the field of scalable hydrogen generation from raw biomass through advanced PEC technology.

EXPRESSION OF INTEREST – CANDIDATE FOR PF GLOBAL

Researcher Profile:

Name and Surname: Not decided yet
Position:
Department/Unit/Centre:

a. Describe your qualifications and experience. Provide information regarding your level of experience on the research topic proposed and your track record of publications, invited talks, and conference participation relative to your career stage (e.g., papers, projects, main international collaborations, patent etc.), highlighting which scientific, technical and soft skills you will transfer to the TC Hosting Institution during the implementation of the Outgoing Phase in your research project.

b. Show your level of independence and demonstrated capacity for leading projects, for example by securing funding, and mentoring students.

Project idea, if any (scientific requirements, topic, discipline):