Korean Researchers Profile

Korea-EU Horizon Europe Researchers Networking Forum 2026 on Cluster 4

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Your Target Call

HORIZON-CL4-2027-01-MAT-PROD-22: Innovative advanced materials and new production processes - reducing dependencies on Critical and Strategic Raw Materials (Innovation Action; Innovative Advanced Materials for the EU and Processes4Planet partnerships)

Your Expected Contribution to the Project / Consortium

I would contribute as a scientific partner, Task Leader, or Work Package Co-leader for materials and interface de-risking. My group can combine first-principles DFT and AI-assisted screening with advanced characterization to identify material and process solutions that reduce the use of Critical and Strategic Raw Materials, improve material efficiency, and clarify performance, durability, and degradation mechanisms.

According to the consortium's selected industrial use case, we can screen candidate two-dimensional materials, MXenes, oxides, van der Waals heterostructures, and functional interfacial or coating layers. Indicatively, we could screen 20–50 material combinations and shortlist 5–10 candidates for experimental validation by consortium partners.

Specific contributions include calculations of stability, defects, band alignment, charge transfer, and ion/electron transport; interpretation of impedance/Cole-Cole, Raman/PL, XPS/XRD, ellipsometry, and electrical data from partner samples; and development of evidence-based material, interface, and process- design rules.

Our resources include materials-simulation workstations and software such as VASP, CASTEP together with electrical, impedance, optical, and ellipsometric characterization capabilities and access to institutional structural and surface-analysis facilities such as SEM, TEM, NMR, ESR, Raman, PL, etc.

Expected outputs include a candidate database, screening and mechanism reports, interface-design rules, validation priorities, and a joint technical evidence package supporting Safe and Sustainable by Design, industrial scale-up, and TRL progression.

Biography

Prof. Se-Hun Kim is Professor of Physics Education in the Faculty of Science Education at Jeju National University, Republic of Korea. He received his B.S. in Physics (1995) and M.S. in Solid-state Physics (1997) from Hanyang University, and his Ph.D. in Solid-state Physics from Korea University (2006). After serving as a postdoctoral fellow at

Korea University, he joined Jeju National University in 2007 and has been a full professor since 2017.

His research connects first-principles materials modelling, advanced characterization, and functional- device analysis. His core interests include advanced energy and semiconductor materials, two- dimensional materials and MXenes, van der Waals heterostructures, graphene, quantum and topological materials, hydrogen-bonded systems, sensors, photodetectors, and battery diagnostics. His methods include DFT, Monte Carlo and quantum-potential models, together with impedance/Cole-Cole analysis, Raman, photoluminescence, optical absorption, ellipsometry, NMR, ESR, XRD, XPS, AFM, FESEM/TEM, and electrical-transport analysis.

Representative achievements include studies of proton dynamics in KDP and Nafion, hydrogen-plasma- modified ZnO, high-permittivity TiOx nanocomposites, lithium-ion battery equivalent-circuit models, strain in epitaxial graphene, ultra-low-power graphene photodetectors, and wide-range, fast-response graphene humidity sensors. He has also led and hosted NRF Brain Pool research on MXene-based optoelectronic and energy materials and maintains international collaborations in computational and quantum materials. He is currently developing partnerships for Horizon Europe Cluster 4 and Cluster 5 proposals. This would be his first formal Horizon Europe consortium participation, with a prospective role in DFT/AI-assisted materials screening, interface analysis, characterization support, and scientific task leadership.

Research Areas / Expertise

- Computational materials design: First-principles DFT, electronic structure, optical and thermoelectric properties, defect energetics, band alignment, charge transfer, ion/electron transport, Monte Carlo and quantum-potential modelling, and AI-assisted candidate down-selection.
- Functional-material platforms: Two-dimensional materials, MXenes, van der Waals heterostructures, graphene, oxides, thin films, semiconductor materials, quantum and topological materials, hydrogen- bonded systems, and advanced energy materials.
- Characterization and mechanism analysis: Impedance spectroscopy and Cole-Cole analysis; Raman, photoluminescence, absorption, and ellipsometry; NMR and ESR interpretation; XRD, XPS, AFM, FESEM/TEM; and electrical-transport and device-response analysis.
- Applications: Battery diagnostics, fuel-cell membrane dynamics, photocatalytic and photovoltaic materials, semiconductor and gas/humidity sensors, photodetectors, dielectric materials, and functional interfaces.

Representative outcomes include atomic-level analysis of proton dynamics in KDP and Nafion; demonstration of an approximately 100-fold conductivity increase in hydrogen-plasma-treated ZnO; lithium-ion battery equivalent-circuit validation; ultra-low-power graphene photodetection; and a graphene- based humidity sensor operating over 4–96% RH with rapid response and recovery.

Relevant project experience includes NRF Brain Pool research on MXene-based optoelectronic and energy materials, MXene/van der Waals heterostructures for clean-energy applications, and international collaborations in computational and quantum materials.

Motivation, Expectation and Plan

- identify an experienced European coordinator and complementary industrial and research partners;
- select a clear industrial product, material, or process dependency related to Critical and Strategic Raw Materials;
- define a concrete Task or Work Package that Jeju National University could lead or co-lead;
- determine appropriate technical, sustainability, CRM-reduction, and scale-up KPIs; and
- establish a realistic proposal-development timetable.

I particularly hope to deepen discussions with the matched European researcher from IMNR, Romania, while meeting additional partners in advanced-material production, pilot demonstration, industrial end use, CRM substitution and recycling, and Safe and Sustainable by Design/LCA/TEA.

Following the forum, I plan to circulate a concise joint concept note within two weeks, organize an online consortium meeting within one month, prepare a partner-gap and Work Package map, and agree on responsibilities, data

exchange, budget principles, and proposal milestones. The ultimate objective is to contribute to a competitive joint proposal for the 2 February 2027 deadline.