



**Consortium**  
**GoFIB – Gallium Oxide Fabrication with Ion  
Beams**  
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# Efficient batteries for sustainable development

## ➤ Major challenge

- ✓ With climate change no long-term sustainable development is possible. Global greenhouse gas emission is still rising leading to temperature increases that dramatically affect food security and livelihoods on the entire planet  
[<https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/>].

## ➤ Attractive solutions

- ✓ Reduce maximally the use of fossil fuels, such as coal, oil, and natural gas, which remain to be the largest sources of energy for heat and electricity generation in the world.
- ✓ Use alternative energy forms that have minimal or no CO<sub>2</sub> emission, such a hydro-, wind- or solar power

## ➤ Obstacles

- ✓ in Europe the most obvious sites for large-scale hydropower are already in use, further increase is limited by environmental and land use right concerns.
- ✓ Wind does not always blow
- ✓ Sun is not easily available in all parts of the globe (Finland is known for long winter nights)

## ➤ Metal oxides for battery applications

- ✓ An obvious solutions is to find methods to store energy produced from renewable sources
- ✓ Among the vary wide range of materials studied, metal oxides are a good base material for battery applications. Many of them have high hardness and good stability under external electric fields, making them good candidates for durable batteries.

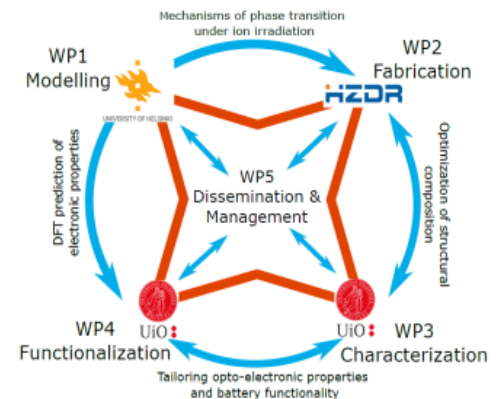
# GoFIB is looking for innovative solutions

## ➤ Why gallium oxide

- ✓ Rich nature of  $\text{Ga}_2\text{O}_3$  polymorphism can enable single-material based new battery technologies.
- ✓  $\text{Ga}_2\text{O}_3$  is a very promising ultra-wide bandgap semiconductor that has received much research interest recently. It has already been demonstrated that this material can be used as an anode in batteries with stable charging and discharging and a very good charge storing capacity [Tang et al, ACS Appl. Mater. Interfaces 2018, 10, 6, 5519–5526].
- ✓ Formation of different polymorphs can be turned into an advantage by gaining control over the single-phase polymorph multilayer and nanostructure fabrication.

## ➤ Research approach

- ✓ Our innovation is in a new method to realize the strain induced polymorph transformations in a technologically viable way using ion implantation.
- ✓ We will utilize highly focused ion beams (HZDR) to induce nanoscale phase transformations that can be used for design of light-weight high efficiency and low dimension battery structures.
- ✓ The experimental fabrication (HZDR), characterization and functionalization (UiO) will be guided by theoretical atomistic modelling equipped by machine-learned description of interatomic interactions on quantum-mechanical level of accuracy (UHEL)
- ✓ Figure illustrates the collaboration links and workflow dependencies





**M-era.Net**

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