TEIÚ Research & Development in Energy

Company Background

TEIÚ Energy was founded in 2020 inside the University of São Paulo (USP) - in the city of **Ribeirão Preto** -because of the collaboration of the PhD projects of its founders, João V. Bonaldo and Décio Freitas. The company has a strong innovation character in its roots, working with energy storage solutions, R&D and technological application of your new materials.

The company **focus is on technological development based on strategic minerals for use in energy storage systems**, our first project was entitled “Development of V_2O_5 and WO_3 bronzes for use as Li-ion battery anodes”. The good progress of the project resulted with the company earning public funding from CNPq/SEBRAE for the project “Development of a binder-free electrode of mixed oxide of V_2O_5 and Nb_2O_5 modified with graphene”, when we produced prototypes **of Li-ions cells that can store up to 2x more energy than traditional cells and operating at current and potential regimes much higher than cells with classical architecture.**

We currently develop solutions for energy storage systems aiming electromobility and stationary systems (BESS) aiming the democratic access to renewable technologies.

The company is incubated in the Supera Parque innovation technology park, which in 2023 was chosen among the Top 5 business incubators in Latin America, where it receives administrative, operational and technological support

Innovation from the roots.

Location

Teiú Energia is in Ribeirão Preto, in the interior of the state of São Paulo; the region is known for its immense energy potential of sugar and alcohol and the strength of the agroindustry

Everything in one place

The company is incubated in the Supera Parque innovation technology park, which in 2023 was chosen among the Top 5 business incubators in Latin America, where it receives administrative, operational and technological support.

Innovation from the roots

Conceived within USP, it is impossible to separate the innovative nature of the company from that of the university. USP continues to be one of the most relevant universities in the world and offers full support for the development of disruptive technologies.

Mission

Democratize access to renewable technologies and reduce national technological dependence through the production of high-tech solutions.

Vision

To be a world leader in the production of energy storage systems.

Values

Diversity, innovation, social responsibility, creativity, appreciation of national technologies, reliability and security.

Infrastructure

The cooperation between TEIÚ Energía, the University of São Paulo (USP) and the SUPERA Technology Park offers a robust and state-of-the-art infrastructure to develop and test new solutions (all TRL levels) in energy storage systems.
Currently, the company has:

- Battery cycler;
- Integrated potentiostat with electrochemical impedance spectroscopy module;
- **High temperature and controlled atmosphere ovens**;
- **Ball mill and cryogenic mill**;
- **Glove box** with strict atmosphere control;
- Infrared spectrometer for sample characterization.
- Thermal analyzer (**TGA/DSC**) to evaluate the thermal stability of new materials;
- **ZetaSizer** for characterization of nanostructures applied to energy storage systems.

Additional information about the equipment and services offered by USP/RP and the SUPERA Technology Park can be found at:

https://quimica.ffclrp.usp.br/caqrp/
https://superaparque.com.br/centro-de-tecnologia/

O que fazemos:

Teiú Energy operates in the **development of electrodes based on nanostructured oxides for use in systems energy storage systems** that have high performance, low cost and recycling feasibility reconditioning

These **oxides** are typically bronzes or lamellar structures that, thanks to their chemical properties, give the solution **greater power and energy density and faster recharging**.

In line with our mission, TEIÚ works by adding value to strategic minerals for national development, benefiting the value chain of national technological independence.

Teiú focuses its efforts on developing domestic solutions for the production of advanced materials for Li-ion batteries that can be used coupled to photovoltaic, wind or electromobility generation. Our focus is to reduce technological dependence on strategic issues such as energy

Energy storage systems

What we develop:

Batteries

Capacitor

H_2V production by electrolysis.

Íons- Li

Supercap

Niobium and graphene-based anodes

Capacity

Power density

Recharge time

V_2O_5 and LiFePO4 cathodes

Capacity

Nominal Voltage

Energy Density

H_2 storage

Safety

Logistical ease

Electrodes for H_2O electrolysis

Use of rare metals.

Overall efficiency

Catalyst poisoning

Current regime

Cost per liter produced

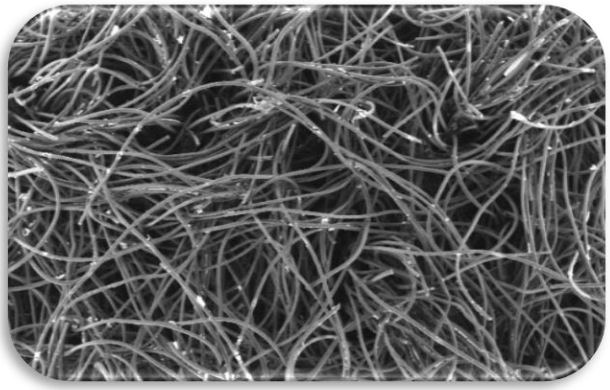
Electrodes for second generation lithium-ion batteries.

Development of anodes based on nanostructured niobium oxides

Development of graphene-modified nanoLFP cathodes.

Binder-free electrodes modified with niobium oxide for use in Li-ion cells

Binder-free electrodes are an innovative technology that eliminates the use of conductivity and cohesion additives during cell manufacturing.
These electrodes are composed of nano or micro-spun carbon fibers depending on the desired application.



Advantages of using carbon fibers:

The fibers allow the electrode to operate in higher current ranges, resulting in higher power density
Provides greater moldability to the solution
They have higher mechanical and chemical resistance

Adhesion of the oxide to the fibers

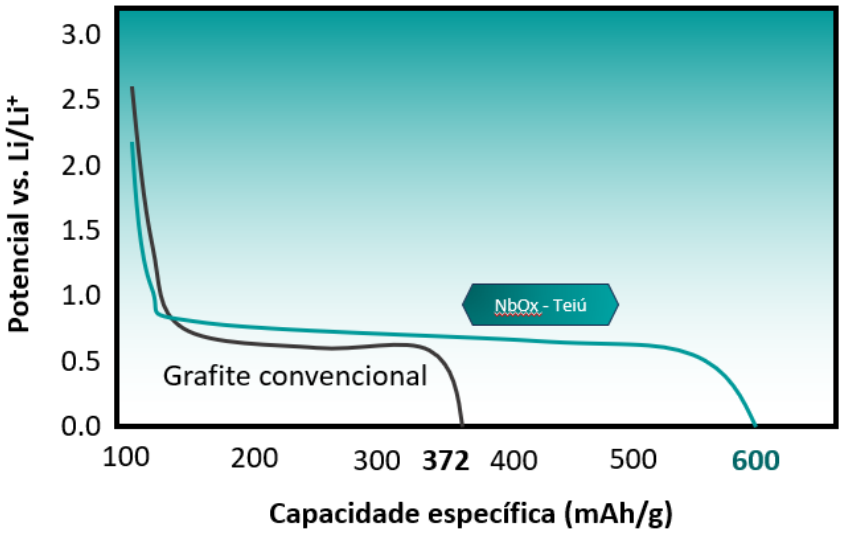
To produce the electrodes, TEIÚ carries out a process that generates a self-adhesive film on the fibers, resulting in a homogeneous and reproducible material.
The result is a malleable electrode covered with niobium nanostructures that is capable of offering greater storage capacity and a shorter recharge time.

Full Charge

Ion diffusion

Volumetric energy

Recharge Time

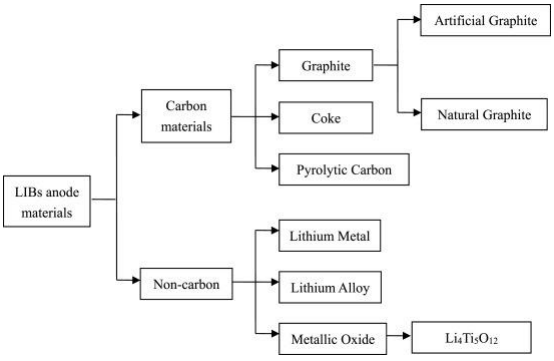


Production of $Li_4Ti_2O_{12}$ nanostructures from vanadium mining process residues

Reduce environmental impact by adding value to raw materials:

Currently, Li-ion batteries mainly use graphite as the anode material, the best performance comes from synthetic graphite which is produced through a petroleum derivative treated at 2000°C, as a result the carbon footprint of lithium batteries increases, and green energy is not converted into that green.

One of the alternatives to increase the performance of cells and reduce their environmental impact is to replace graphite with metal oxides; Just as niobium stands out among the alternatives, titanium oxide is widely explored and presents results that allow its use as a substitute for graphite.



Hui Yan, et al.,https://doi.org/10.1016/j.ceramint.2020.10.241.

Brazil has one of the most significant vanadium mines in the world, located in Maracás, in the state of Bahia. The mine produces 11 tons of vanadium per year, however, this production generates significant amounts of titanium oxide as a byproduct that is stored in dams. TEIÚ Energía uses this by-product to produce lithated titanium oxide nanostructures that can be used as an alternative to graphite in lithium-ion cells. This process reduces the environmental footprint of the farm, decreases the amount of waste generated and increases the added value of the product.

Nano -$Li_4Ti_2O_{12}$

Environmental impact

Power

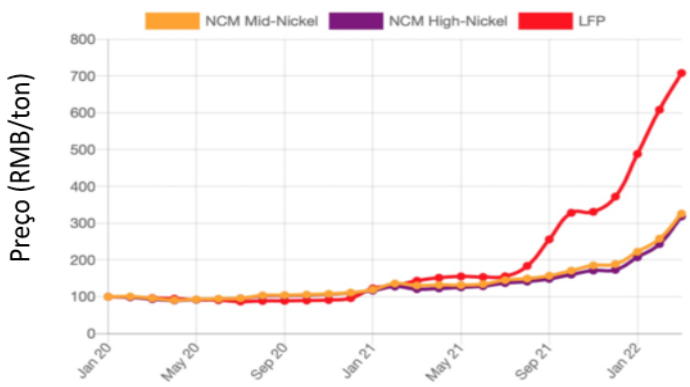
Added value

The technological and economic feasibility of this substitution has already been explored by Toshiba, which, by 2030, intends to launch graphite-free lithium-ion cells using or

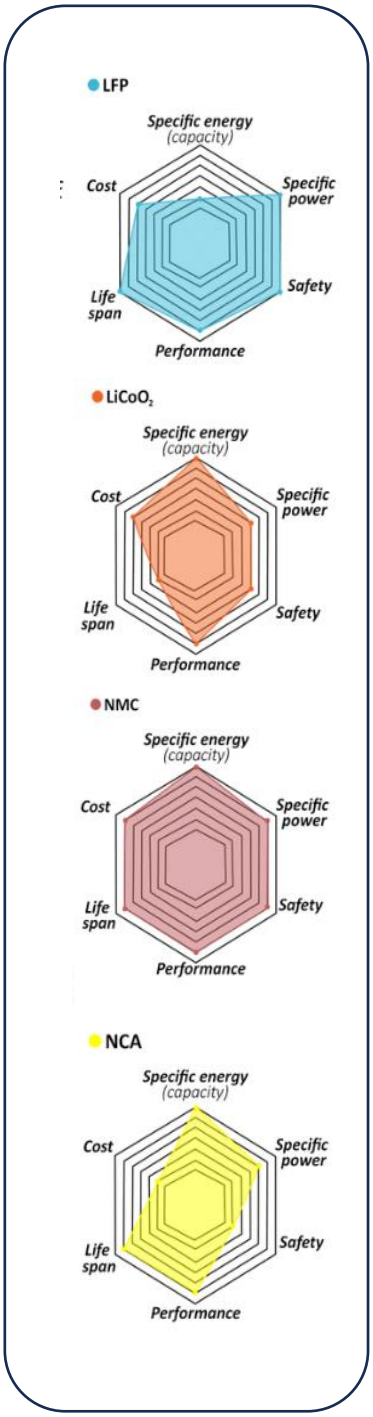
Production of LiFePO4 (LFP) Nanostructures from Niobium Mining Waste

LFP has emerged as the primary option for acting as cathodes in lithium-ion cells; currently, major cell assemblers such as CATL, BYD, Moura and UCB already adopt this material in their production line.
Until 2021, the price of LFP was relatively low compared to other possible options, however, this value is increasing substantially due to the loss of patents by CATL and the increasing demand for the material.

Raw Material Cost for Li-ion Cell Production



Currently, some commodity mining processes generate large amounts of magnetite (iron ore) as a residue from the concentration of the ore of interest. TEIÚ Energía has a partnership with CBMM, the world's largest niobium producer, to use its mining waste as feedstock to produce graphene-modified LFP (produced from biomass) to offer nationally a product with excellent performance and high added value, while reducing the generation of waste in dams.

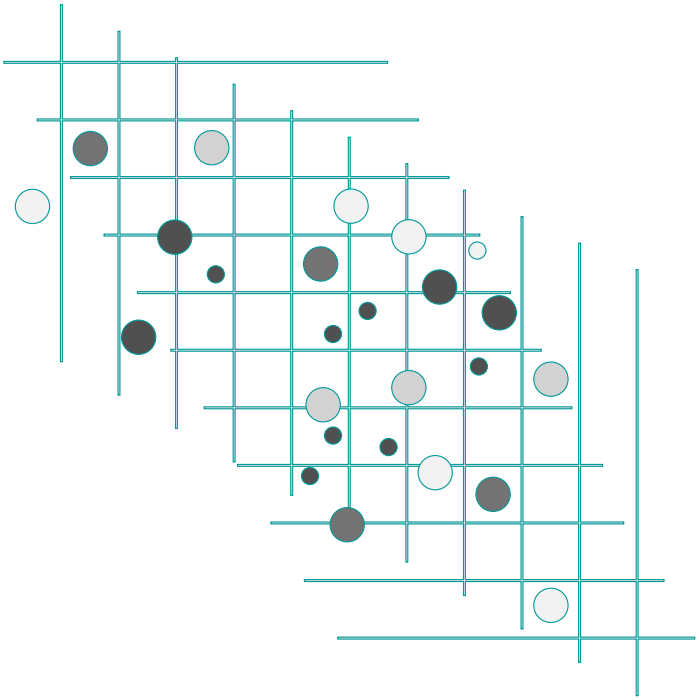


Teiú- LFMP

- **Environmental impact** ↓
- **Logistics Cost** ↓
- **Best value for money** ↑
- **National offer** ↑

Development of electrodes for the production of green hydrogen by electrolysis

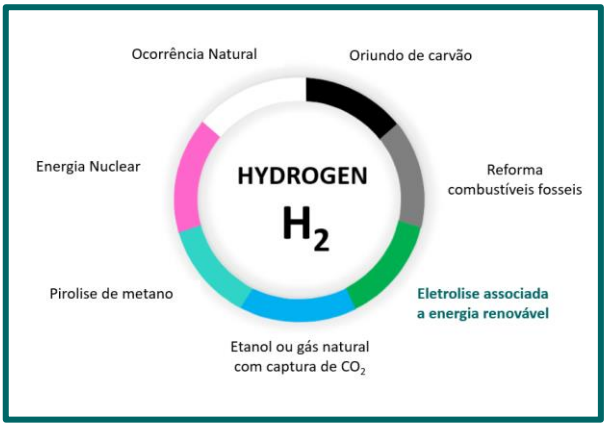
Development of low-rare metal electrodes for H_2 production in low-current regimes.



Ni/Pt catalyst with excellent cost-benefit for the evolution of hydrogen by electrocatalysis.

Green hydrogen production:

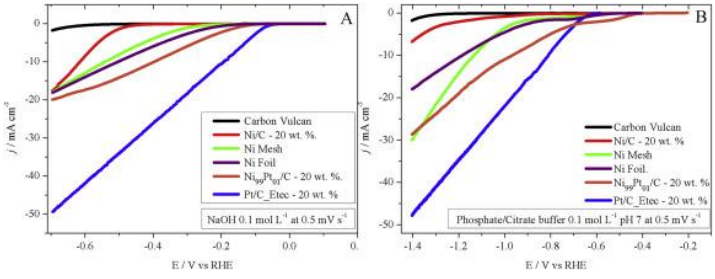
Hydrogen plays the central role in the energy transition, currently most of the hydrogen produced comes from natural gas steam reforming (grey H2) or through ethanol reforming (blue H2); The production of truly green hydrogen occurs through the decomposition of water molecules by electrolysis; This process is also known as water splitting. Currently, the biggest challenge for large-scale and economically viable H2V production lies in the catalysts used for hydrogen release, usually the electrode with the best performance is Pt, an expensive metal with a short useful life.



In partnership with USP/RP, Teiú produces a Ni/Pt electrocatalyst that significantly reduces the total cost of the material by using only 1% Pt in its composition.

In addition to having high corrosion resistance, the material can operate in different current and pH regimes, making it an excellent candidate for systems connected to, for example, wind or solar power.

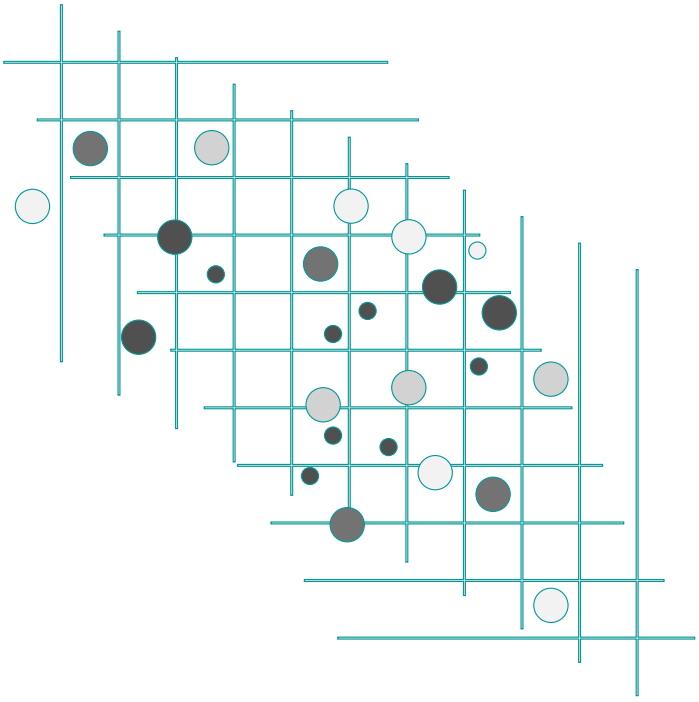
With low overpotential and reduced cost, the catalyst can make the production of green hydrogen economically advantageous and ecologically sustainable.



A detailed study of the material can be found at:
[Preparation and characterization of active and cost-effective nickel/platinum electrocatalysts for hydrogen evolution electrocatalysis - ScienceDirect]

Next Generation Battery Solutions

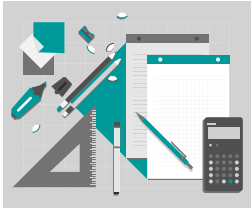
Developing solutions for a more sustainable future for all



Sodium Battery Electrodes

TEIÚ is currently developing, together with FAPESP, electrodes based on niobium bronzes for use in sodium-ion batteries; The development aims to create a battery with 100% domestic technology that reduces the cost of energy storage by up to 50%;

Solid-State Batteries



Following market trends, TEIÚ is evaluating the production of an electrolyte modified with sugarcane graphene (biochar) for use in solid-state batteries; Although still in its early stages, the process is capable of generating nanofibers by electrospinning that have an excellent diffusion coefficient and can allow the use of solid-state batteries at room temperature.

What we're looking for:

Investment

- Infrastructure **expansion**
- **HQP**
- Development of **adressed solutions**
- Construction of a pilot plant for the **production of LFP and niobium oxides**

Partnerships

- Development of **new strategic materials**
- Development of **new markets**
- Mutual development of batteries for **stationary storage and electromobility applications**

Teiú

The Energy for tomorrow, Today.

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