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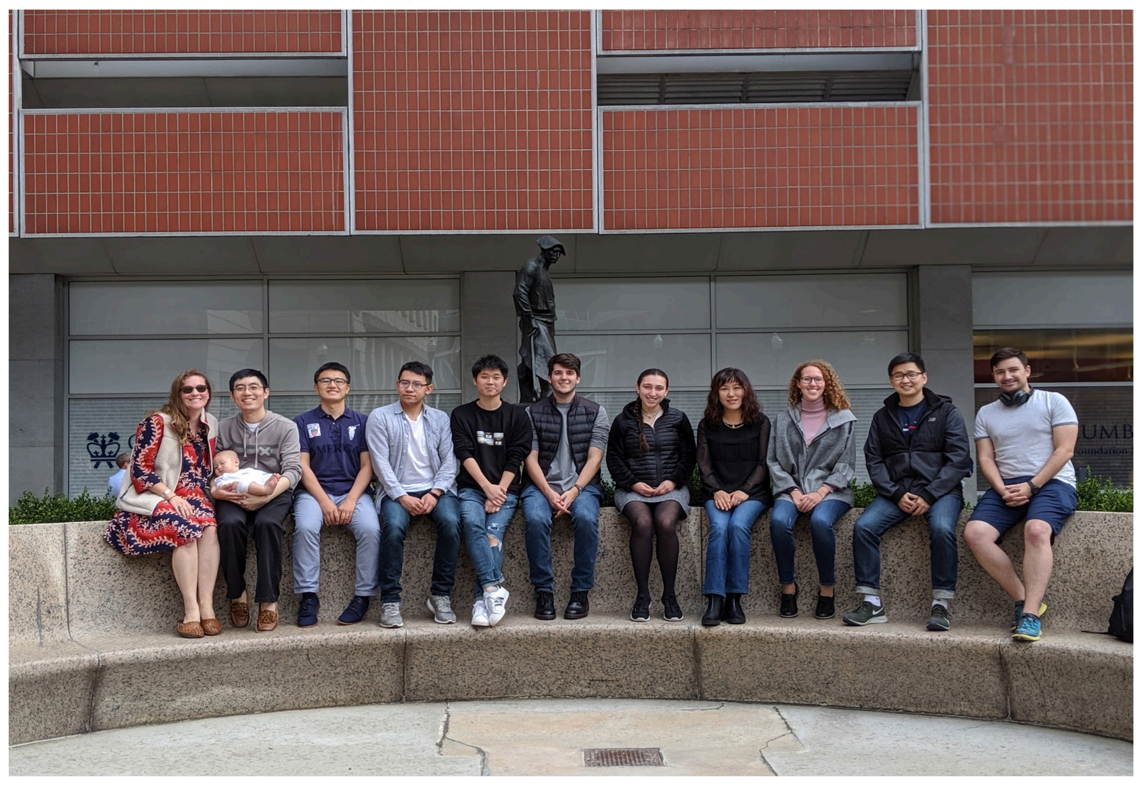
Lenfest Center for Sustainable Energy
Earth Institute | Columbia University

Overview

Developing innovative technology to ensure sufficient supply of environmentally sustainable energy for all humanity

Research topics:

- Energy Storage
- Carbon Capture, Utilization and Storage
- CO2-to-Chemicals, Materials and Fuels
- Unconventional Resources, electronic wastes, and REEs
- Energy and Materials Conversion Pathways
- Built Environmental and Infrastructure
- Fluidization and Multiphase reactors

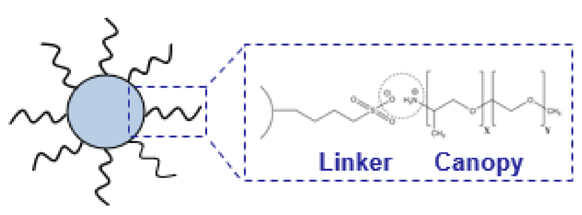


Park Group Photo (Taken Fall 2019)

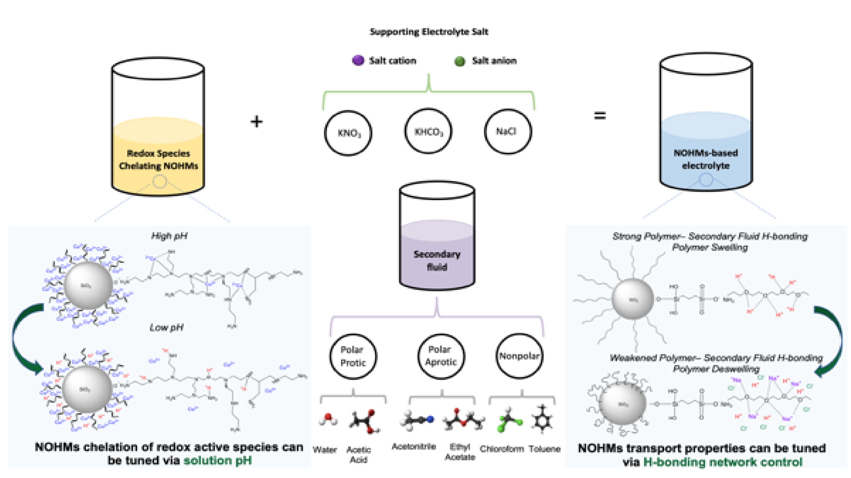
CO_2 Capture, and novel electrolytes for sustainable energy storage

Overview and the use of NOHMs

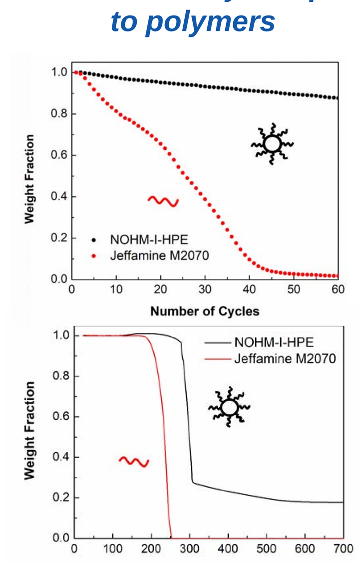
Nano-scale Organic Hybrid Materials (NOHMs) are solvent-free liquid-like systems that have high thermal stability, structural and chemical tunability, and negligible vapor pressure



NOHMs have unique electrolyte behaviors with high CO2 loading capacity



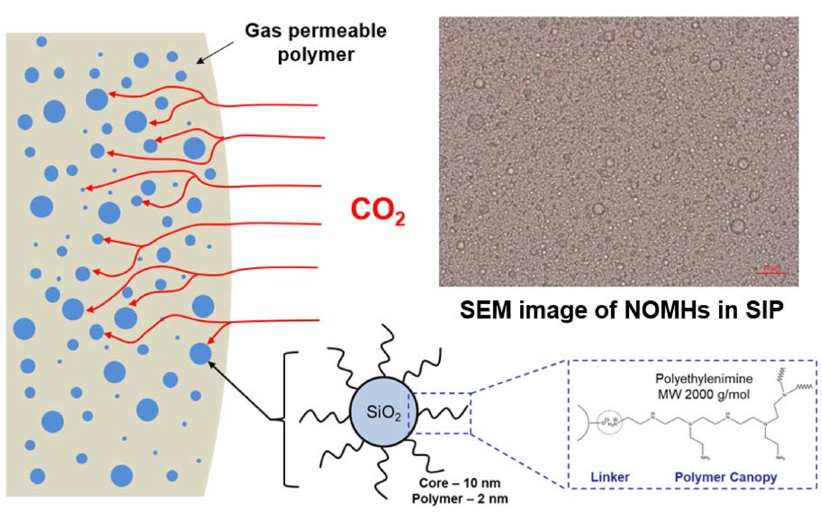
NOHMs show good thermal-oxidative stability compared to polymers



Thermal oxidative stability tests of NOHMs vs. conventional amine polymer

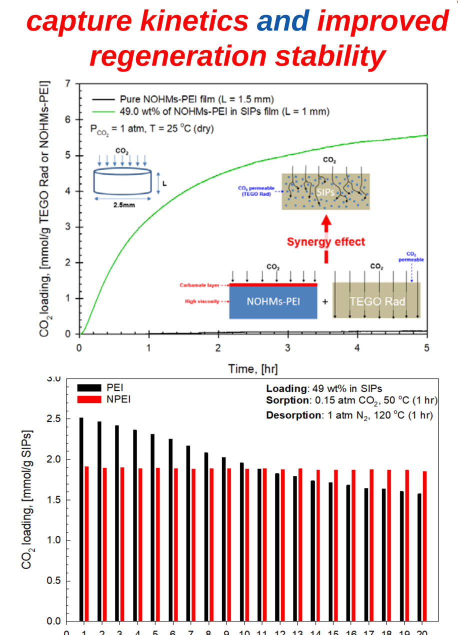
CO_2 Capture Using NOHMs

NOHMs can be used as solvent impregnated polymers (SIP) for CO_2 capture



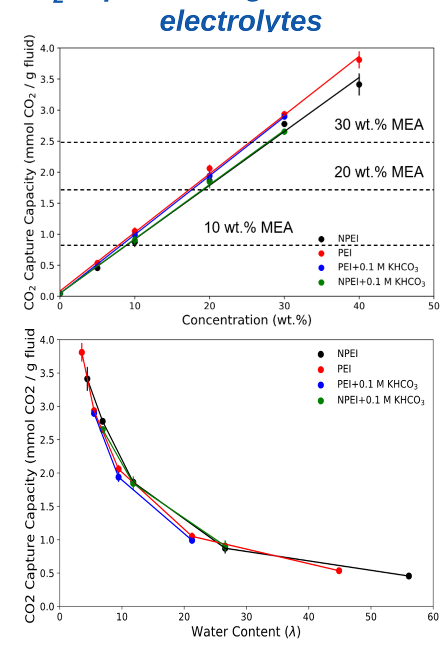
SEM image of NOHMs in SIP

NOHMs in SIP showed faster CO_2 capture kinetics and improved regeneration stability



CO2 capture (top) and cycle tests (bottom) using NOHMs in SIP

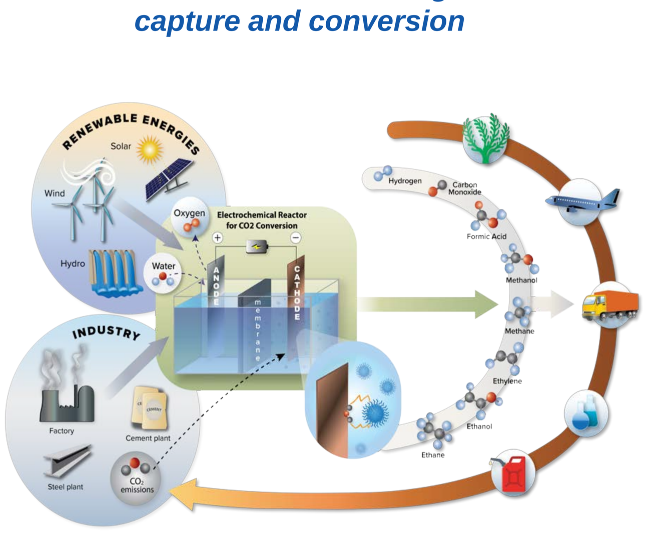
CO_2 capture using NOHMs-based electrolytes



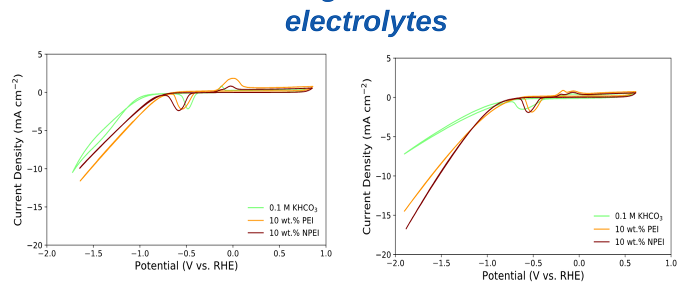
CO_2 Uptake results as a function of concentration (top) and water content (bottom)

NOHMs as electrolytes for renewable energy storage applications

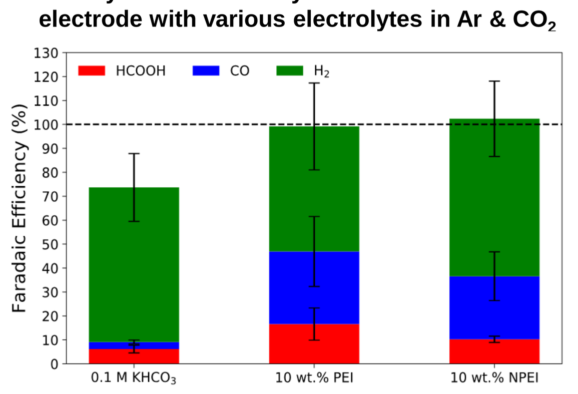
Research scheme combining carbon capture and conversion



Conversion of CO_2 to chemical and fuels using NOHMs-based electrolytes

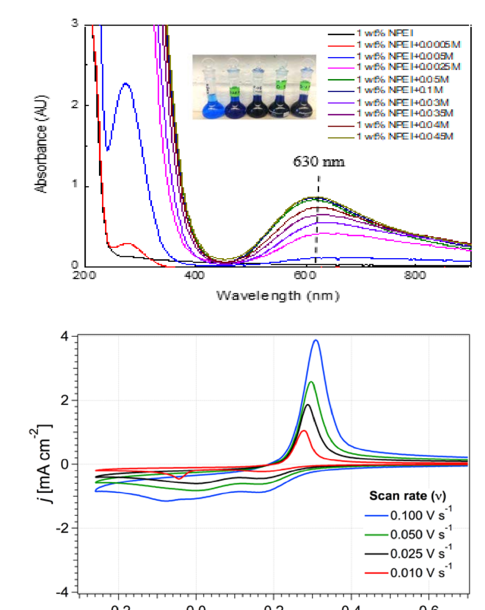


Cyclic Voltammetry results on Indium electrode with various electrolytes in Ar & CO_2



Electrolysis data comparing the selectivity of various electrolytes

NOHMs can selectively coordinate Cu(II) to stabilize the Cu (I) intermediate during electron transfer.

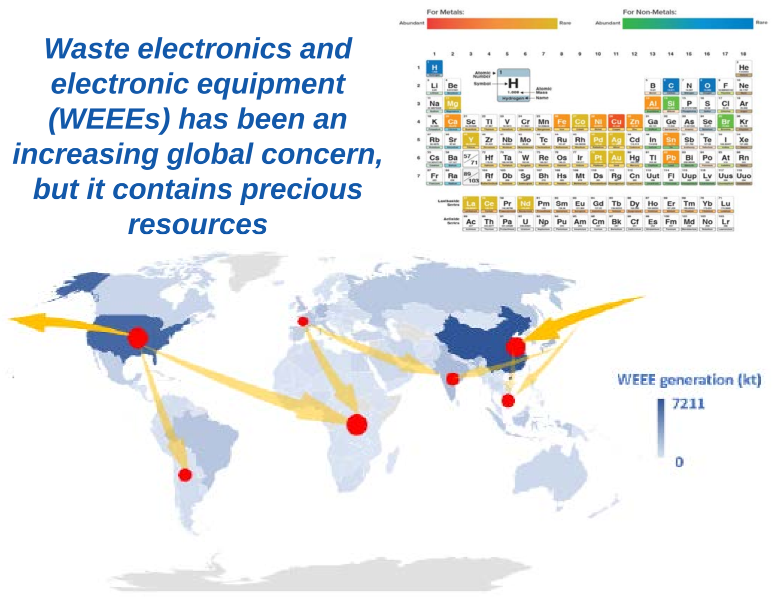


UV Visible spectroscopy (top) and cyclic voltammetry (bottom) results for NOHM-I-PEI chelation.

Resource recovery from unconventional wastes

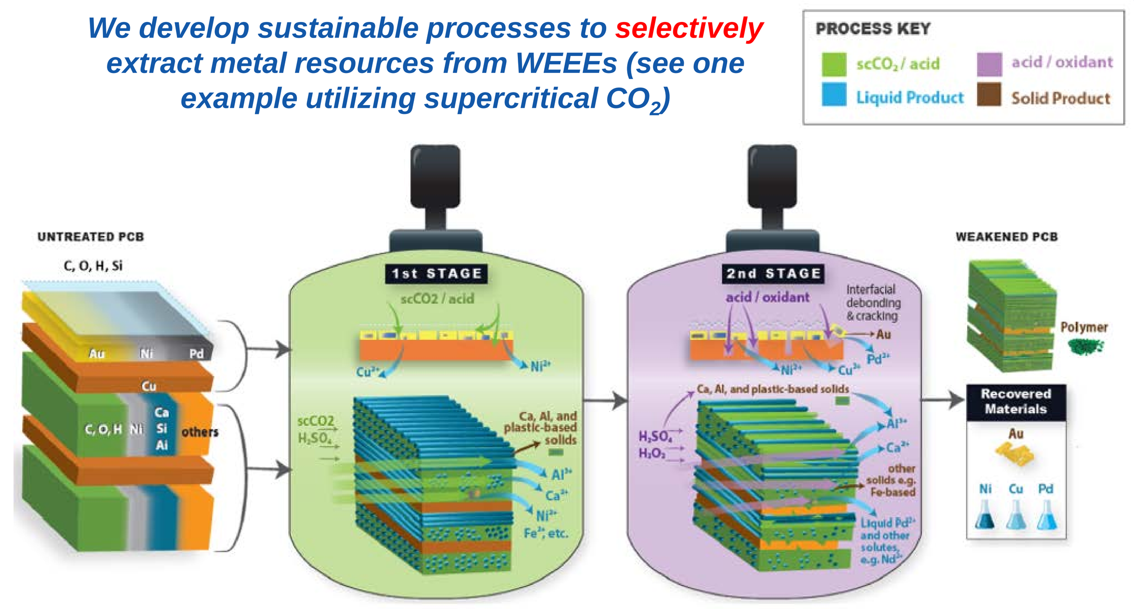
Resource recovery from electronic wastes

Waste electronics and electronic equipment (WEEEs) has been an increasing global concern, but it contains precious resources

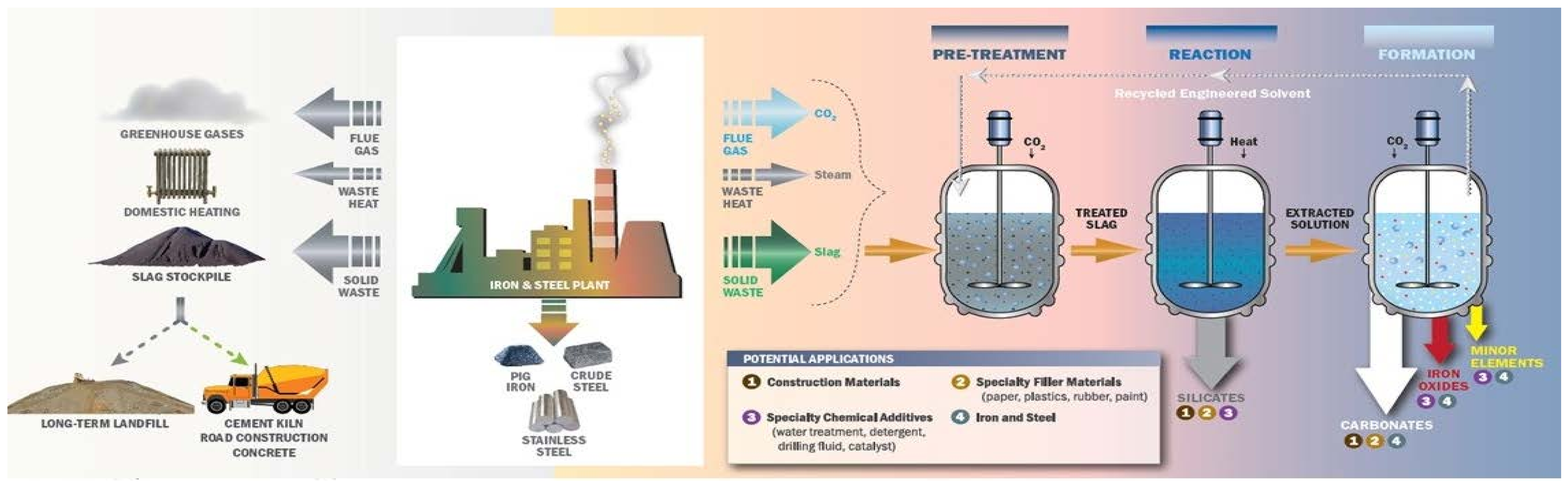


The global generation and transportation of WEEEs

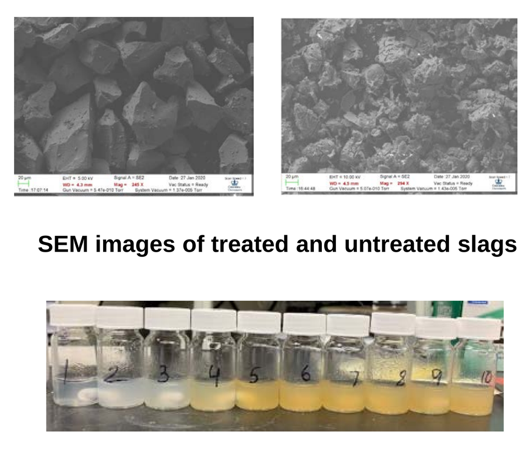
We develop sustainable processes to selectively extract metal resources from WEEEs (see one example utilizing supercritical CO_2)



Carbon mineralization and metal extraction using industrial waste

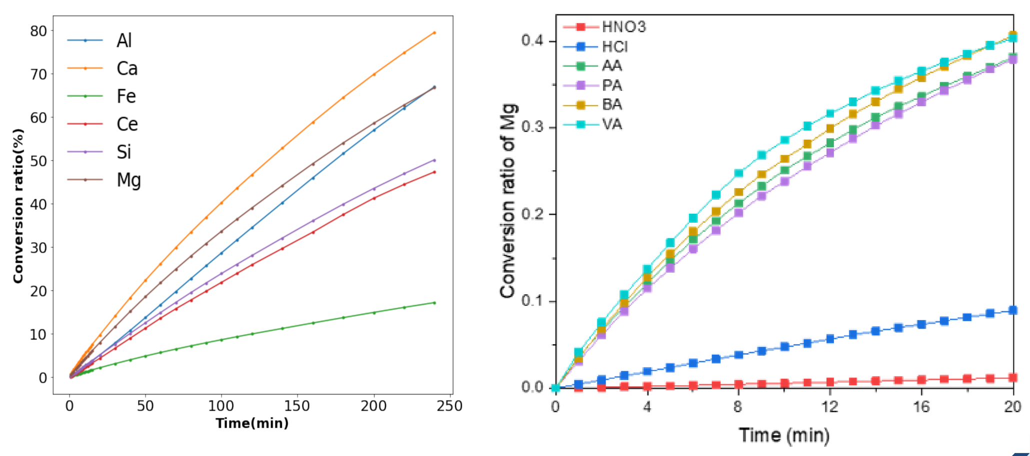


We study the kinetic of major elements dissolution, and develop a pH swing process to precipitate rare earth elements (REEs)-enriched particle metal oxide (PMO)



SEM images of treated and untreated slags

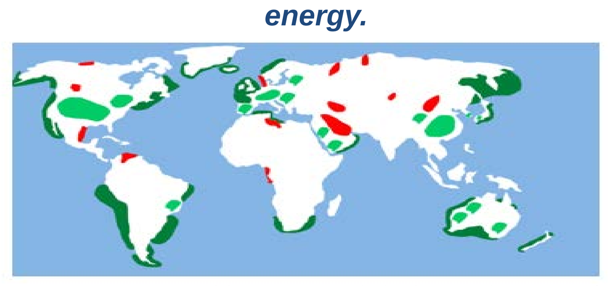
Samples of REEs-enriched PMOs during the pH swing process



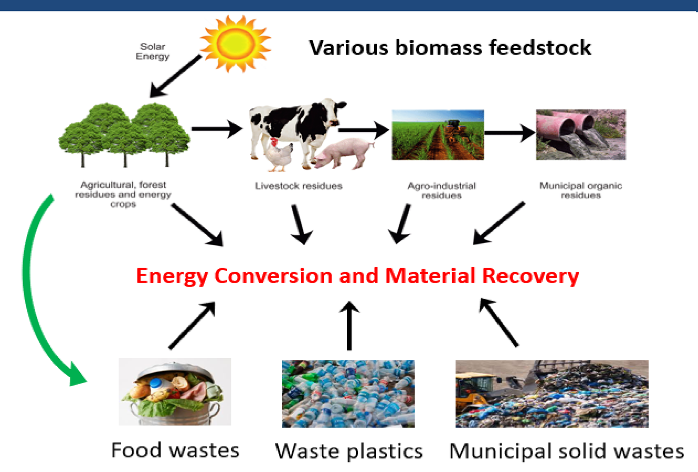
Examples of REEs and alkaline metal extraction results from iron (left) and steel slags (right)

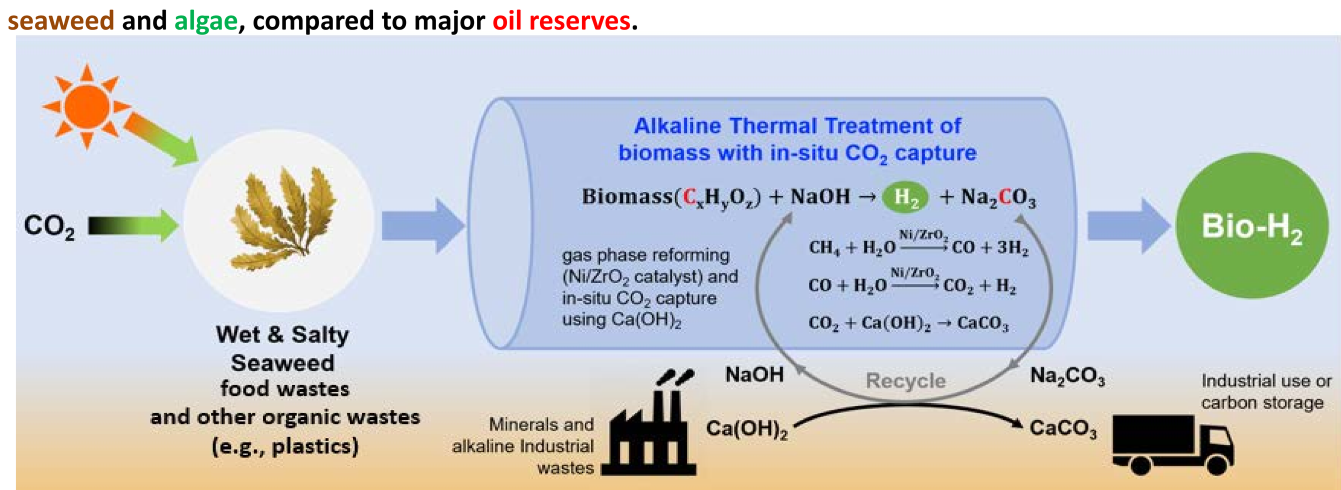
Energy and material conversion

We develop carbon neutral or even negative technologies to convert carbon from wastes to value-added solid carbonates, and simultaneously generate energy.

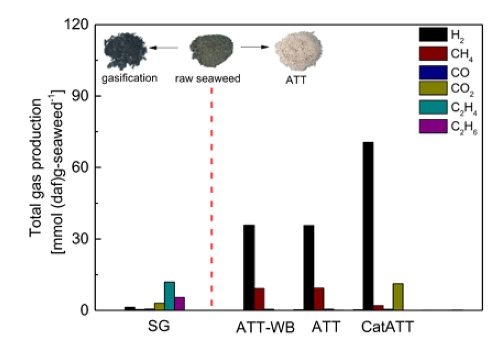


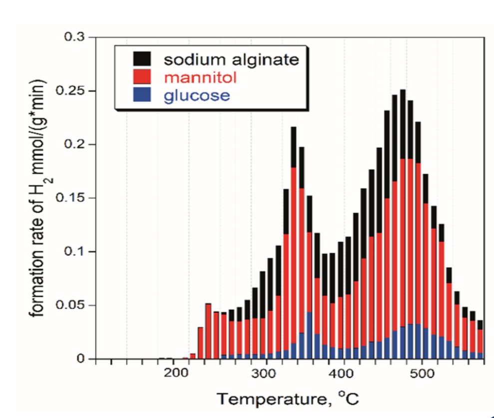
Unconventional biomass: Global distribution of seaweed and algae, compared to major oil reserves.





The catalytic alkaline thermal treatment (ATT) reaction can convert the wet and salty biogenic wastes to high-purity H_2 with CO_2 capture.





Funding agencies & collaborators

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