tcg crest

Inventing Harmonious Future

Research Institute for Sustainable Energy (RISE)

Sustainable Energy for a Better Future Through Excellence in Research, Education, Outreach and Collaboration

Vision of RISE

Vision

High-end and cutting-edge research in clean energy as well as IP creation

Excellence in higher education and capacity building

Technology development aligned with National Mission

Product-targeted industry interactions encouraging start-ups

National and international collaboration and co-operation with leading institutes and scientists around the globe

Constant eye on potential societal impact

National and international data-based trend analysis – cost, human development, urban vs. rural markets and businesses

Sustainable Nation Building

Prof. Satishchandra Ogale
Director – RISE

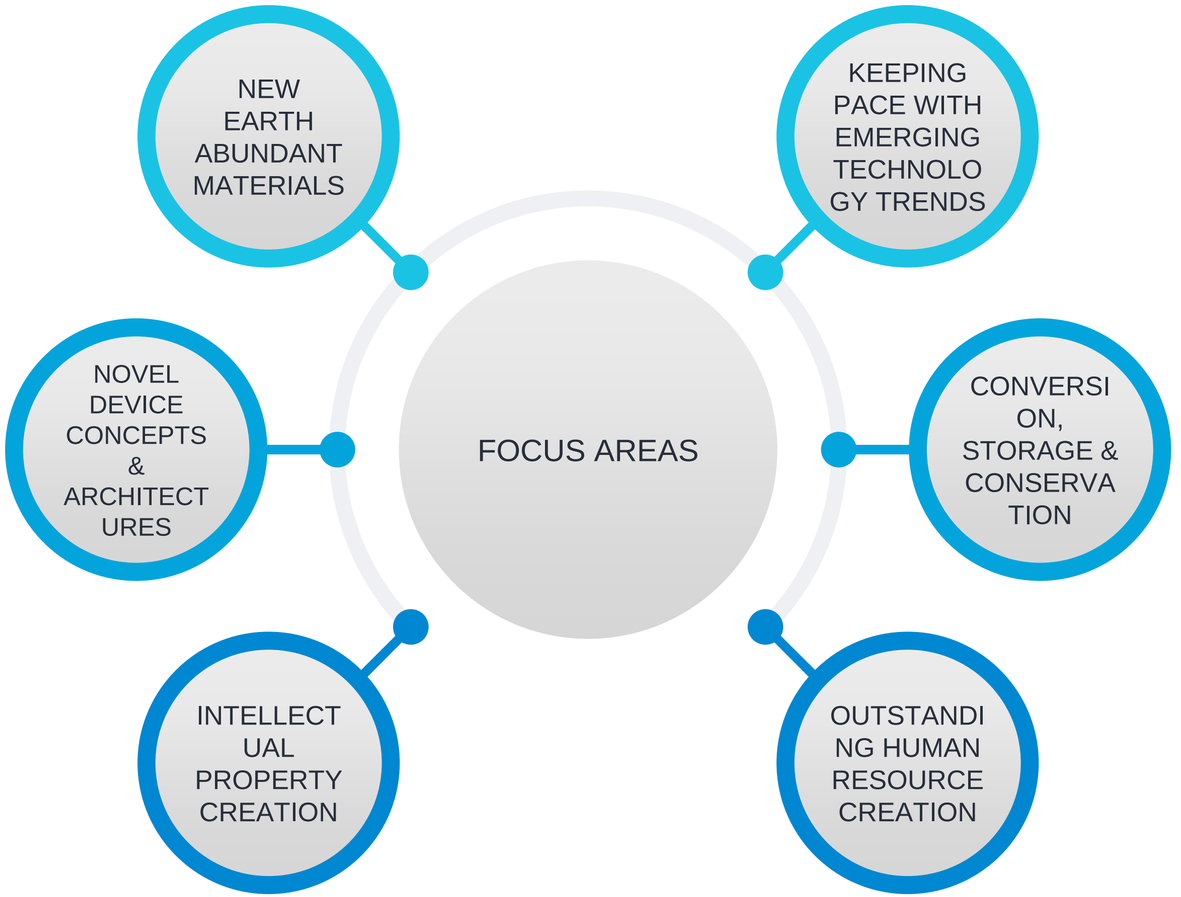
Prof. Ogale was the Chair of Physics at Pune University prior to joining the Department of Physics and Center for Superconductivity Research, University of Maryland as a Senior Research Scientist (1996-2006). He was the first Ramanujan Fellow of DST at the National Chemical Lab where he was the Chief Scientist until 2015, when he left. In 2019, he was selected for the coveted Raja Ramanna Fellowship of the Department of Atomic Energy. He is now the Professor Emeritus of IISER-Pune, apart from being the Director of RISE. Prof. Ogale has worked in several fields like CMR Manganites, High-temperature Superconductors and Spintronics. His current research focus is on developing new materials for clean energy harvesting, storage and conservation. He has co-authored about 500 research publications and has nine granted US patents.

Objectives of RISE

THE SUSTAINABILITY EQUATION: RENEWABLE ENERGY = CLEAN ENVIRONMENT + GOOD HEALTH

GUIDING PRINCIPLES

- VISION
- EXCELLENCE
- DISCOVERY
- INNOVATION
- APPLICATION
- PRAGMATISM



Opportunities

GenNext Solar Cells

Solar Water Splitting for Hydrogen

CO_2 Reduction

Green Fuels

New Battery Chemistries

Super-capacitors

Hybrid Devices

Solid State Lighting (LEDs)

Metal Oxides
Sulfides
Semiconductor QDs
Hybrid Perovskites Polymers
MOFs
COFs
Small Molecules
Dyes
Ionic Liquids
Gels
Organometallics
Inorganic Materials
Low Dimensional Materials

Functional High Surface Area Carbon, Metal Oxides/Sulphides,

Conducting Polymers, Mesoporous Materials,

Engineered Hetero-junction Systems and Interface Science

Initial Research Focus

BATTERIES AND ULTRA-CAPACITORS KEY FOCUS

Solid State Batteries

Flexible Batteries

Thin Film Batteries

Li- & Na-ion Batteries; enhanced performance in Coin & Pouch Cells

Novel and Scalable Synthesis of Battery Materials

Battery Systems for Electric Mobility

Battery Systems for Grid Scale Storage

Dynamic Analysis of National and International Trends in Battery Materials, Chemistries, Device Architectures and Applications

HYDROGEN ENERGY

Hydrogen Generation Schemes

Hydrogen Storage

Hydrogen Transportation

Fuel Cell Materials

Fuel Cell System Components

Novel Catalysts based on Earth Abundant and 2D Materials for Oxygen Evolution Reaction (OER) & Hydrogen Evolution Reaction (HER)

New Materials for Membranes and Gas Diffusion Layer

Weight, Cost, Performance and Application Domain Analysis

CO_2 REDUCTION & CLEAN FUELS

Evaluation of Schemes for CO_2 Reduction, Interface Engineering & Identification of Challenges

Computation Surface Science of Molecular Adsorption Phenomena and Energetics for CO_2 Activation

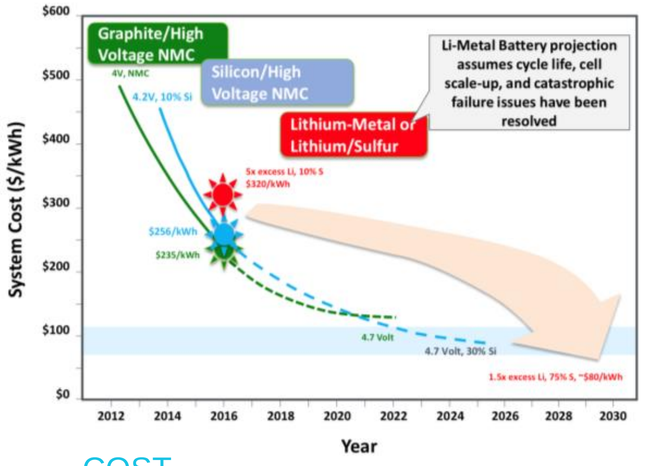
Development of Novel Catalysts, Photocatalysts, Electrocatalysts for CO_2 Conversion to Clean Fuels

Studies on Specific Crystal Facets, Nanomaterials (Metal Oxides, Suphides, Nitrides), Nanocomposites, 2D Materials (Chalcogenides, g-C_3N_4, Layered Double Hydroxides and MXene Phases)

System Design, Cost and Safety Considerations for Realistic Applications

Primary Challenges

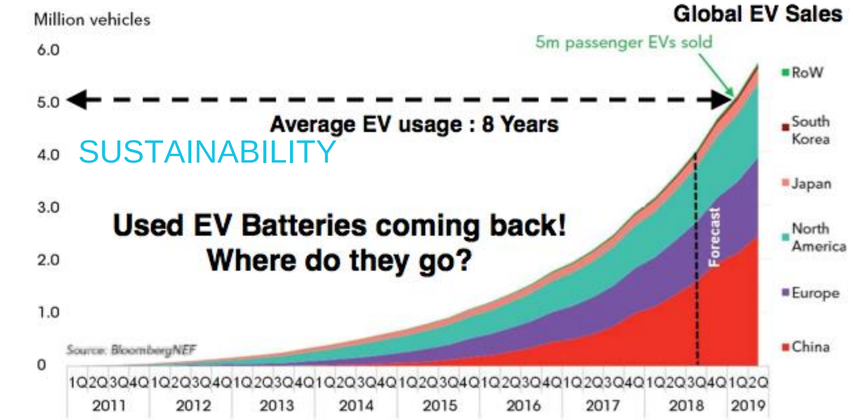
ENERGY | COST | SAFETY | SUSTAINABILITY

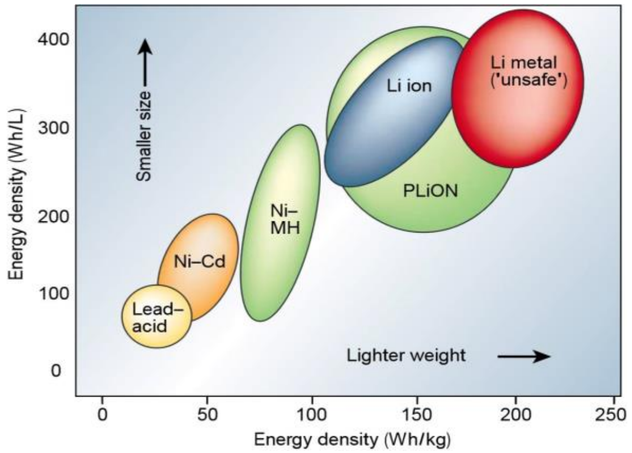


COST

Asia / East Asia

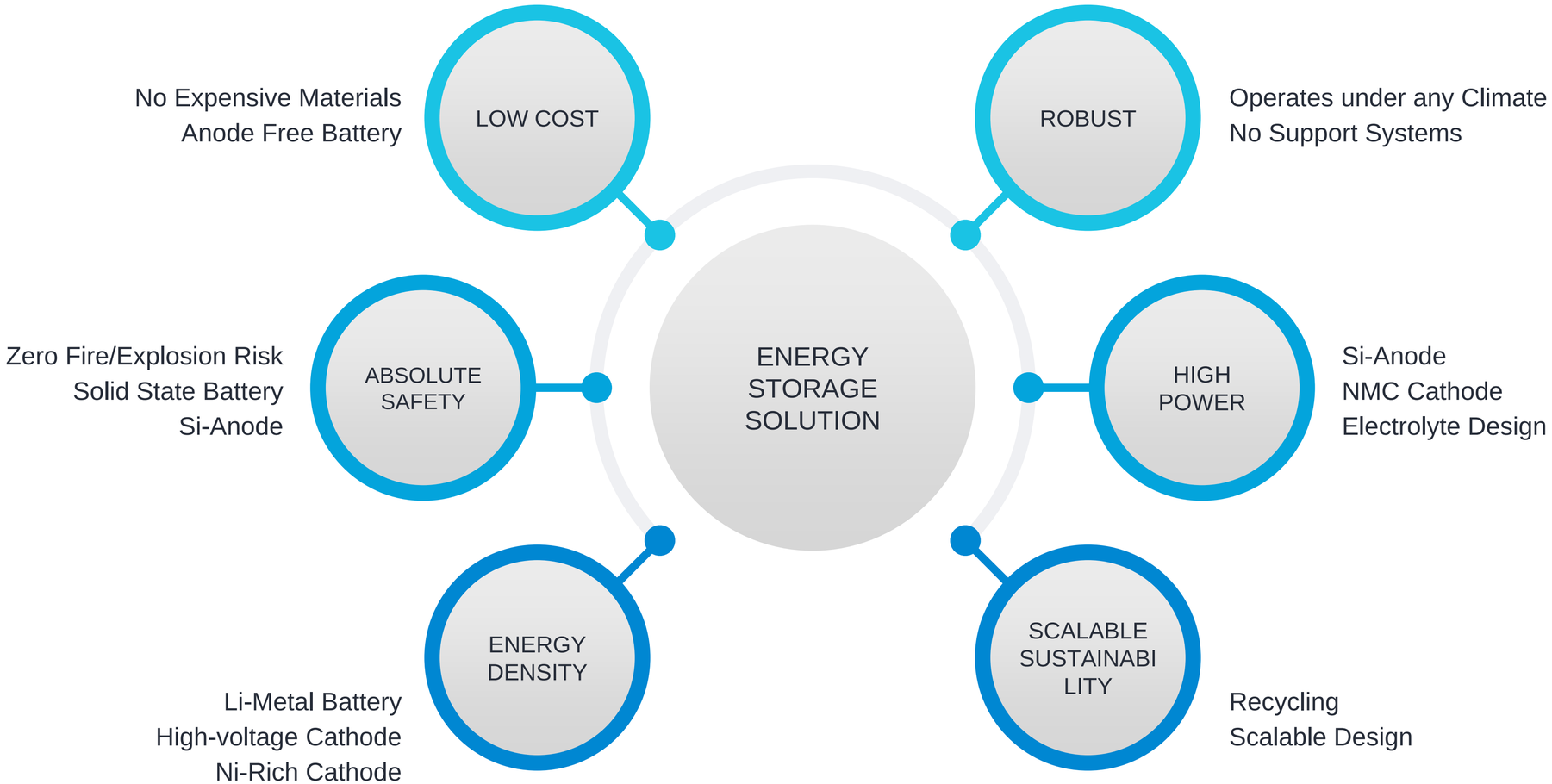
New Delhi firefighter killed, 19 injured, as battery factory collapses after major blaze SAFETY





ENERGY DENSITY

RISE Energy Storage Solution



Goals, Challenges, Domains and Deliverables

MAJOR GOALS

Li metal in LE: 400 Wh/kg energy density; 80% capacity retention after 500 cycle

Solid State Battery: energy density 350 Wh/kg; 80% capacity retention after 500 cycle

Si enabled cost effective fast charging (20 min): Energy density of 220 Wh/kg; 70% capacity retention after 500 cycle

CHALLENGES

Thick Cathode loading of 4mAh/cm^2

Thinning down the SE layer thickness.

Electrolyte design for Li metal and Si anode.

Bottleneck of interfacial charge transfer limitation

1 Ah Pouch cell production.

APPLICATION DOMAINS

EV and hybrid EV

Consumer electronics

Defense

Aerospace

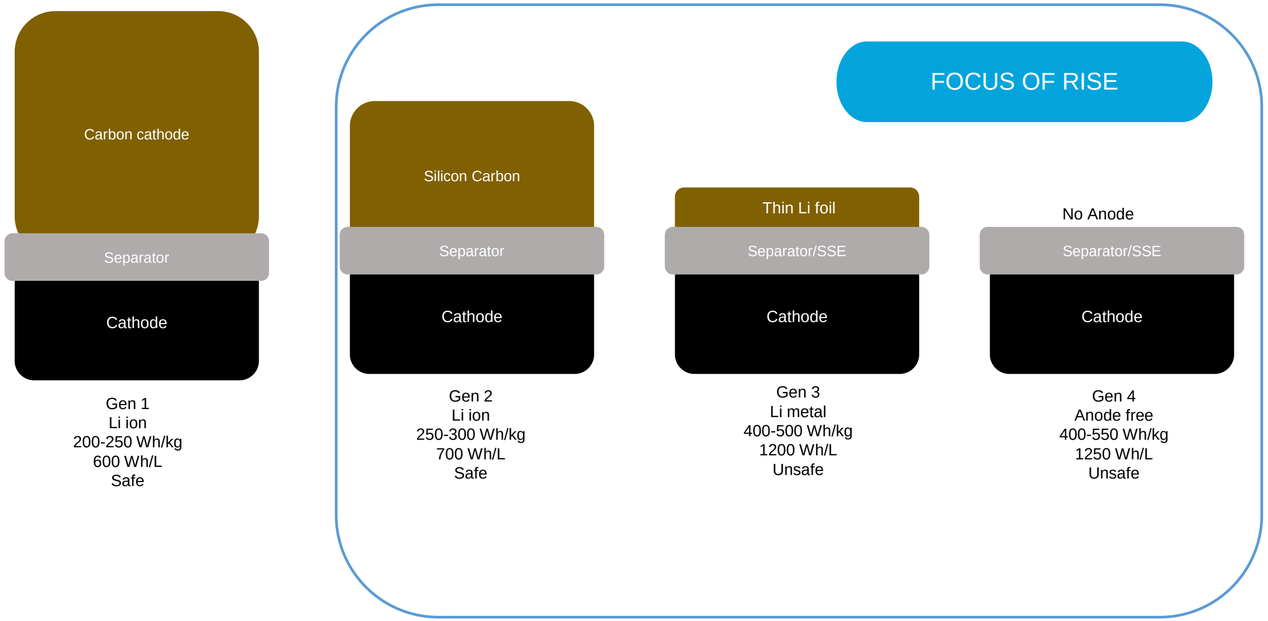
DELIVERABLES

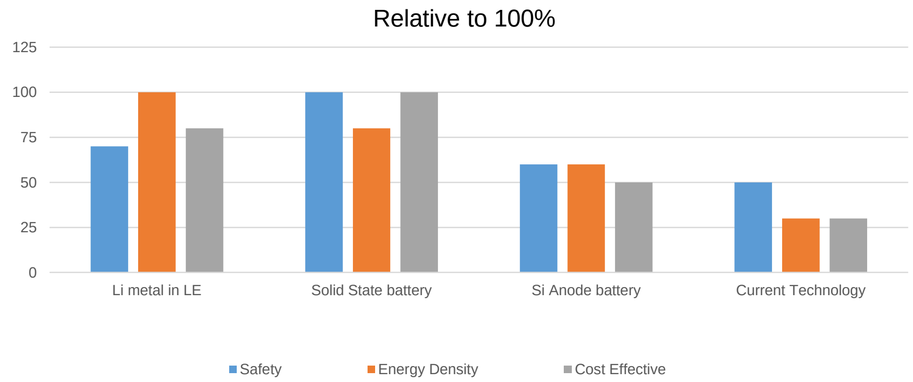
High Impact article

Patent

Startup

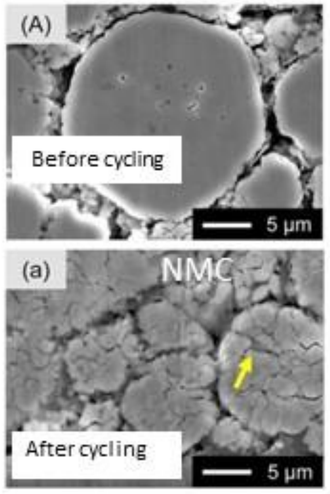
Goals, Challenges, Domains and Deliverables





RISE Strategy

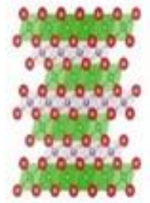
Nature Nanotechnology volume 15, 170–180(2020)

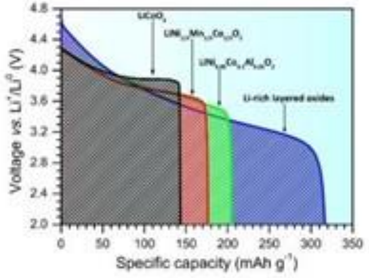


Journal of The Electrochemical Society, , Volume 166Number 3

Capacity Degradation
Regeneration Process
Mechanism
Re-cycling
Battery Recycling

Composition Design
Grains Morphology
Nano-structure Engineering
Meso-structure Control
Materials Synthesis

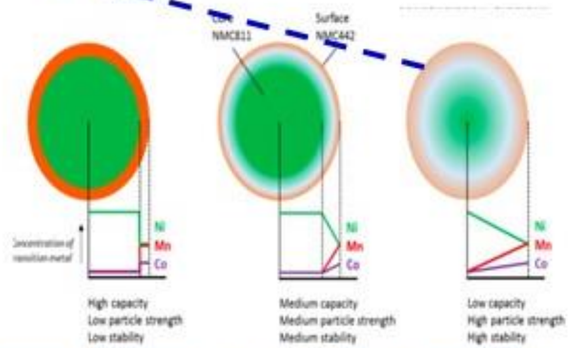




Chem. Mater. 2017, 29, 3, 908–915

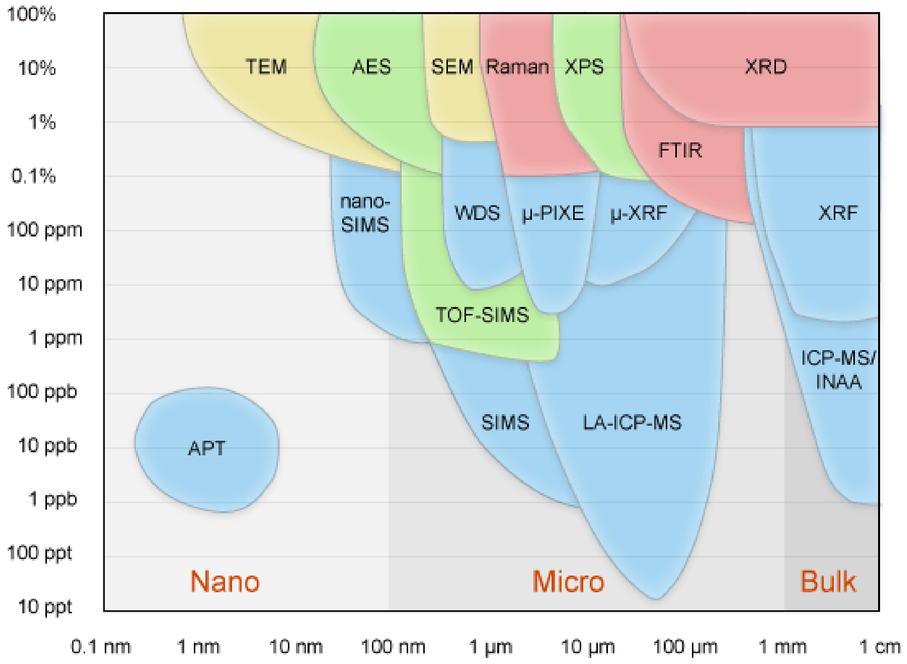
Homogeneous Doping
Surface Treatment
Core-Shell Structure
Surface Doping
Materials Modification

Reaction heterogeneity
Kinetic Issue
Channel Structure
Thick Electrode
Electrode Fabrication



https://www.energy.gov/sites/prod/files/2018/03/f49/FY2016_APR_Advanced_Batteries_R%26D_Part-3of5-opt.pdf

Characterization Challenges and Sustainable Energy Lab



REQUIRES CAREFUL EXPERIMENTAL DESIGN

Spatial Resolution
Energy Resolution
Detection Limit
Bulk vs. Local Observation
Dynamic States & Changes
E Beam & X-ray Sensitivity
Destructive / Non-destructive
Sample Transfer & Contamination
Buried Under Electrolyte

AT RISE

State-of-the-art characterization tools – XRD, XPS, Raman, XPM, Dual Beam Microscope – for measurements at different lengths and time domains

Tools integrated with operando measurement – heating, electrochemical cycling, passing gas, pressure and the like to acquire dynamic information

Integration of tools with glove box for reliable data collection avoiding contamination

Five glove box integrated solid state pouch cell assembly – a first in India

Cryo Gallium based Dual Beam Microscope for tomographic analysis of beam sensitive materials , such as Lithium and Sodium – a first in India

Collaboration with several Laboratories across the world (UCSB, UCSD, UCB, NCL, IISERP, IITs) for characterization

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Inventing Harmonious Future

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