Operando Science and Instrumentation

Esther S. Takeuchi
Vice-Chair, BESAC
SUNY Distinguished Professor
William and Jane Knapp Chair in Energy and the Environment, NAE, NMTI, NAI , NIHF

Departments of Chemistry; Materials Science and Chemical Engineering
Brookhaven National Laboratory; Energy and Photon Sciences

BROOKHAVEN NATIONAL LABORATORY

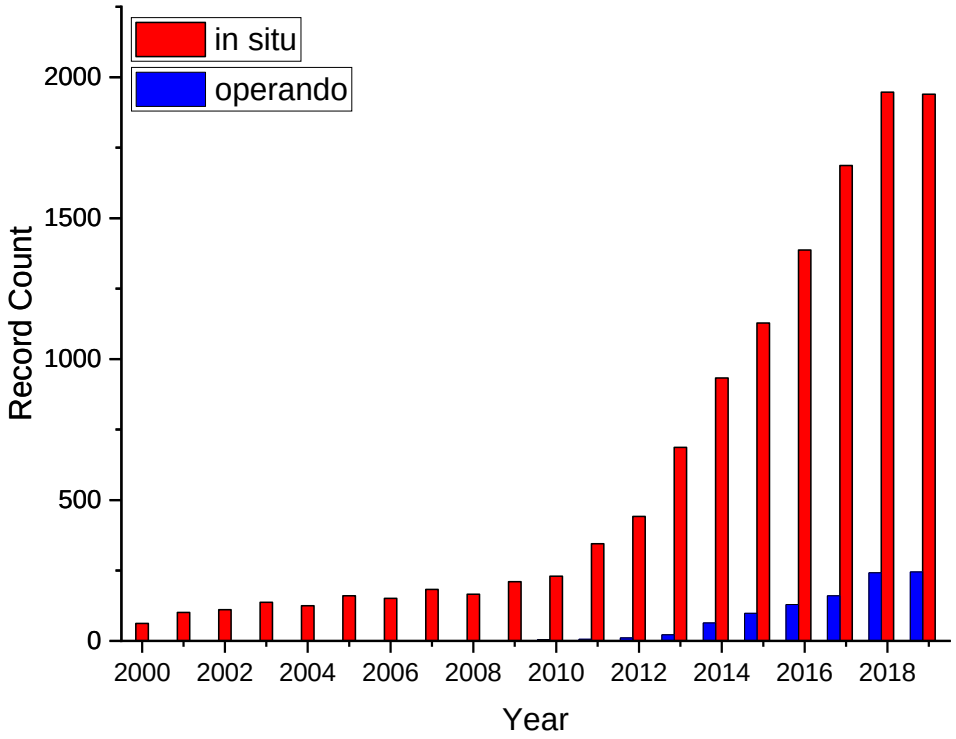
Stony Brook University

Terminology Relevant to Mechanistic Investigations

Ex-situ
Parts removed for analysis outside the functional environment.

In-situ
Measurement of property or material in working environment, system may be not operating at time of measurement.

Operando
Probe of system while operational. Gain information on kinetics and transient species in functioning environment.



Web of Science November 2019
Battery + in-situ or operando

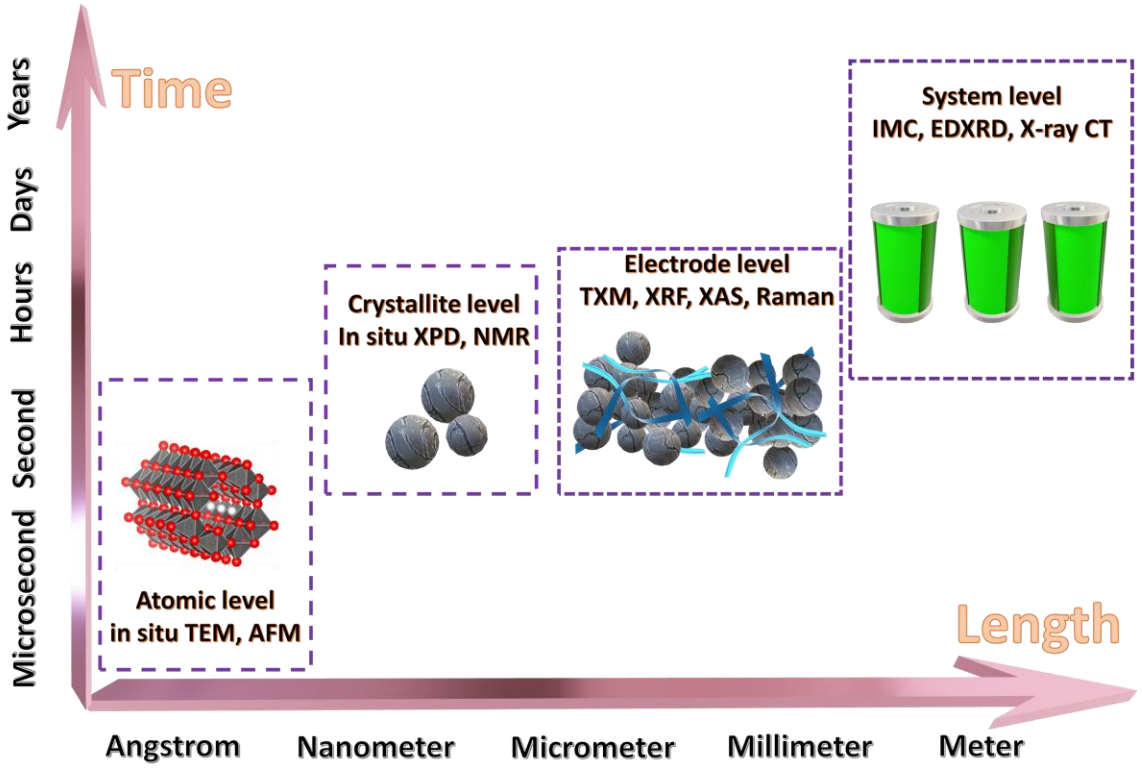
Chemical Sciences Roundtable, NAS. Advances, Challenges, and Long-Term Opportunities in Electrochemistry: Addressing Societal Needs. Nov. 18 & 19, 2019

Relevant Length and Time Scales

Relevant time and length scales often extend over many orders of magnitude

In situ and operando techniques with the corresponding spatial and temporal resolution are shown schematically

Multiple techniques are often needed to capture information needed for full interpretation



Li, Wenzao; Lutz, Diana M.; Wang, Lei; Takeuchi, Kenneth J.; Marschilok, Amy C.; Takeuchi, Esther S. Joule, **2021**, 5(1), 77-88, *invited.*

Operando Science and Instrumentation Panel

- Synchrotron X-ray Research: Johanna Nelson Weker, SLAC National Accelerator Laboratory
- Neutron Science Research: Ashfia Huq, Sandia National Laboratories
- Microscopy Research: Katherine Jungjohann, National Renewable Energy Laboratory
- XFEL X-ray Research: Leora Dresselhaus-Marais, Stanford University

- Panel Lead: Esther Takeuchi