

Exponent®
Engineering & Scientific Consulting

Matevz Frajnkovic, Ph.D., P.E.

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Professional Profile

Dr. Frajnkovic specializes in heat transfer, computational fluid dynamics (CFD), transport phenomena, and fast charging battery systems. Dr. Frajnkovic has performed experimental and numerical analysis of advanced electrochemical energy storage systems. He has experience with measuring the heat generation rate during cycling of batteries and capacitors via isothermal operando calorimetry technique.

Dr. Frajnkovic has extensive experience with experimental techniques such as galvanostatic cycling (GC), cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), galvanostatic intermittent titration technique (GITT), and isothermal operando calorimetry. These non-destructive/non-invasive techniques can be used to monitor the heat generation rate and the state of health during cycling of batteries and capacitors. In addition, Dr. Frajnkovic has working experience with battery thermal runaway incidents, CFD simulations of the thermal/mechanical systems using commercial software packages, such as Star-CCM+, Ansys CFX and Fluent, and Comsol, as well as three-dimensional computer aided design (3D-CAD) modeling with software packages such as SolidWorks and Catia.

During his time at Exponent, Dr. Frajnkovic has worked on product testing and development of custom-made testing setups and protocols. He regularly performs thermal/mechanical system failure testing with interdisciplinary teams. Dr. Frajnkovic has worked on steam service and operations both experimentally and computationally to ensure regulatory compliance of industrial facilities. Dr. Frajnkovic has also performed field work with sample collection and origin/cause investigations related to wildfires as well as structure fires.

Prior to joining Exponent, Dr. Frajnkovic was a research assistant at University of California, Los Angeles (UCLA) where he carried out his doctoral work. His focus was on measuring and identifying the thermal signature of physicochemical phenomena occurring in hybrid supercapacitors during cycling. Dr. Frajnkovic also used numerical simulations to develop expressions for irreversible heat generation rates which exceeds Joule heating in hybrid supercapacitors. Moreover, he measured entropic potential evolution to elucidate the kinetics and structural evolution of novel battery electrode materials.

Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, University of California, Los Angeles (UCLA), 2022

M.S., Mechanical Engineering, University of Maribor, Slovenia, 2017

B.S., Mechanical Engineering, University of Maribor, Slovenia, 2015

Zois Fellowship for Academic Excellence at University of Maribor, Slovenia, 2012-2017

The Sole Recipient of the Best Student Award, University of Maribor, Slovenia, 2017

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The Frank Kerze and Therese Kerze-Cheyovich Research Assistantship for the Study of Transport Phenomena in Complex Systems, UCLA, Los Angeles, California, 2017-2022

Licenses and Certifications

Professional Engineer Mechanical, California, #42545

40-Hour Hazardous Waste Operation and Emergency Response Certification (HAZWOPER) (CA)

Certified Forklift Operator for Sit-Down Counterbalanced Forklifts (CA)

FAA Part 107 Certified Commercial Drone Pilot

Fire Investigation 1A (Cause and Origin), California Office of State Fire Marshal (CA)

Professional Affiliations

American Society of Mechanical Engineers (ASME)

National Fire Protection Association (NFPA)

The Electrochemical Society (ECS)

UL 875 – Electric Dry-Bath Heaters – Technical Committee, Voting Member

UL 499 – Electric Heating Appliances – Stakeholder, Non-voting

Languages

Bosnian

Croatian

Serbian

Slovenian

Publications

Journal Publications:

Ott B, Welchert NA, Delafontaine L, Frajnkovic M, Reza A. Considerations for the safe handling and processing of unstable materials, Process Safety Progress 2024; 1-9.

Zhou Y, Frajnkovic M, Likitchatchawankun A, Munteshari O, Mei B-A, Pilon L. Three-dimensional step potential electrochemical spectroscopy (SPECS) simulations of porous pseudocapacitive electrodes. Electrochimica Acta 2024; 505:144934.

Baek SW, Salamat CZ, Elizalde-Segovia R, Das P, Frajnkovic M, Zhou Y, Thompson BC, Narayan S R, Tolbert S H, Pilon L. Measuring heat dissipation and entropic potential in battery cathodes made with conjugated and conventional polymer binders using operando calorimetry. ACS Applied Polymer Materials 2024; 6, 9, 4954-4963.

Zhou Y, Luo Y, Patterson A, Baek SW, Frajnkovic M, Seshadri R, Dunn BS, Pilon L. Microcalorimetry electrothermal impedance spectroscopy (ETIS) informs entropy evolution at individual electrodes of

PNb9O25 or TiNb2O7 battery cells. Electrochimica Acta 2023; 468:143072.

Baek SW, Wyckoff KE, Robertson DD, Frajnkovic M, Zhou Y, Tolbert SH, Seshadri R, Pilon L. Operando calorimetry investigation of particle size effects on heat generation in Wadsley-Roth (W0.2V0.8)3O7-based electrodes. ACS Applied Energy Materials 2023; 6, 3, 1355-1367.

Frajnkovic M, Likitchatchawankun A, Douard C, Zhou Y, Baek SW, Catton I, Crosnier O, Brousse T, Pilon L. Calorimetry can detect the early onset of hydrolysis in hybrid supercapacitors with aqueous electrolytes. Journal of Power Sources 2022; 548:232069.

Zhou Y, Le Calvez E, Baek SW, Frajnkovic M, Douard C, Gautron E, Crosnier O, Brousse T, Pilon L. Effect of particle size on thermodynamics and lithium ion transport in electrodes made of Ti2Nb2O9 microparticles or nanoparticles. Energy Storage Materials 2022; 52:371-385.

Baek SW, Preefer MB, Saber M, Zhai K, Frajnkovic M, Zhou Y, Dunn BS, Van der Ven A, Seshadri R, Pilon L. Potentiometric entropy and operando calorimetric measurements reveal fast charging mechanisms in PNb9O25. Journal of Power Sources 2022; 520:230776.

Baek SW, Wyckoff KE, Butts DM, Bienz J, Likitchatchawankun A, Preefer MB, Frajnkovic M, Dunn BS, Seshadri R, Pilon L. Operando calorimetry informs the origin of rapid rate performance in microwave-prepared TiNb2O7 electrodes. Journal of Power Sources 2021; 490:229537.

Likitchatchawankun A, DeBlock RH, Whang G, Munteshari O, Frajnkovic M, Dunn B, Pilon L. Heat generation in electric double layer capacitors with neat and diluted ionic liquid electrolytes under large potential window between 5 and 80 °C. Journal of Power Sources 2021; 488:229368.

Conference proceedings:

Frajnkovic M, Catton I, Fisher TS. Melting of Nitrogen-Deuterium mixtures. Kuhljevi dnevi 2019; 33-40.

Ivanic A, Frajnkovic M, Adanic L, Lubej S. Comparison of various techniques for flexural strengthening of thin concrete members using continuous carbon fibers. Kuhljevi dnevi 2016; 75-81.

Adanic L, Frajnkovic M, Necemer B, Belsak A, Ren Z. Split-Hopkinson pressure bar (SHPB) test apparatus. Kuhljevi dnevi 2015; 1-8.

Peer Reviews

International Journal of Heat and Mass Transfer

Journal of Electrochemical Energy Conversion and Storage

Heat Transfer Engineering Journal

ASME Open Journal of Engineering

International Society of Offshore and Polar Engineers (ISOPE)