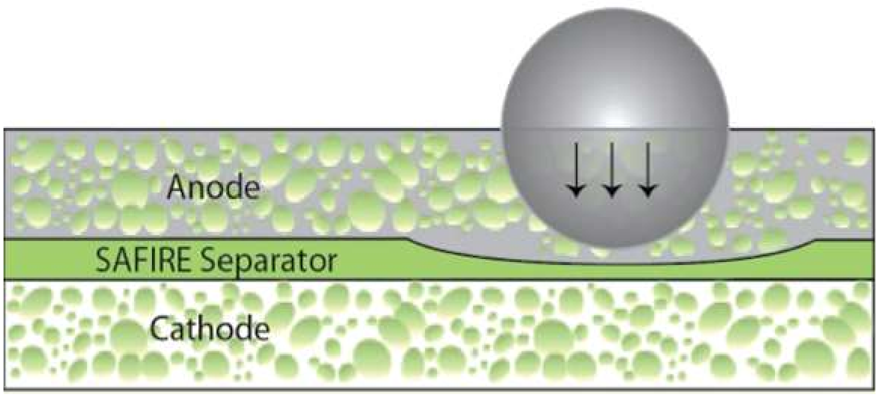
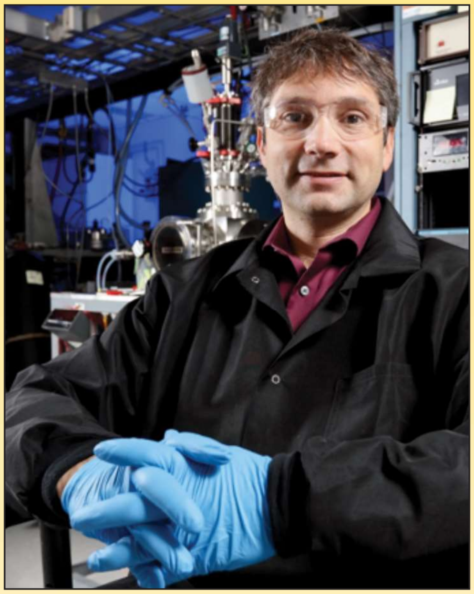
Safe Impact Resistant Electrolytes (SAFIRE)

Problem: Images of electric vehicles and personal electronics on fire demonstrate the problematic reality of lithium-ion batteries. The electrolyte in a lithium-ion battery is traditionally built from highly flammable organic solvents that present a fire hazard in the event of an internal short circuit—contact between positive and negative electrodes.

Solution: This project focuses on the scale-up and safety demonstration of ORNL's shear thickening electrolytes for advanced battery applications. The Safe Impact Resistant Electrolyte (SAFIRE) transformative design results in the electrolyte functioning as a safety feature of the battery and eliminating the risk of thermal runaway. The SAFIRE electrolyte is a liquid under normal operating conditions, allowing solvents to wet all the electrode surfaces just like a traditional battery electrolyte. However, upon impact, as caused by a car crash or some other mechanical impact event, the additive causes the electrolyte to undergo an immediate and massive rheological shift to become a solid. The solid barrier prevents the positive and negative electrodes from coming into contact and short circuiting. By preventing the electrodes from touching, none of the energy stored in the battery components is released.



Impact: Emerging technology markets, such as those within the automotive industry, depend on safe electrical energy storage. The SAFIRE electrolyte challenges previous notions regarding battery safety/engineering and will turn the electrolyte into an intrinsic part of the battery safety envelope. Beyond the safety aspects of this electrolyte, the value added from this technology enables the redesign of battery packaging and battery placement to introduce design flexibility to end users. Additional SAFIRE market impact is in US military applications, specifically batteries that double as body armor and/or safer portable drone batteries.



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Dr. Gabriel Veith is a senior research staff member and team lead for the Thin Film and Fundamental Electrochemistry group within the Materials Science and Technology Division at ORNL. His research focuses on the development of new materials and processes related to energy storage/conversion applications as well as fundamental studies of liquid-solid interfaces. He has 176 published papers, four patents, six patents submitted, and two R&D 100 awards.

Intellectual Property

Impact Resistant Electrolyte; US20160093917 A1

Shear Activated Impact Resistant Electrolyte; US20170104236A1

Stabilized Shear Thickening Electrolyte; ID-3814

Fabrication of Films and Coatings Using Shear Thickening, Impact Resistant Electrolytes; ID-3634

ID-3025 Impact Resistant Electrolyte; US9590274B2

ID-3633 Shear Activated Impact Resistant Electrolyte, US20170104236A1

ID-3634 Fabrication of Films and Coatings Using Shear Thickening Impact Resistant Electrolytes; 15/958,448

ID-3814 Stabilized Shear Thickening Electrolyte; 15-835,696

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Publications

- Brian H. Shen, Gabriel M. Veith, Beth L. Armstrong, Wyatt E. Tenhaeff, and Robert L. Sacci, "Predictive design of shear-thickening electrolytes for safety considerations," *Journal of the Electrochemical Society*, 164(12), A2547–A2551 (2017).
- Gabriel M. Veith, Beth L. Armstrong, Hsin Wang, Sergiy Kalnaus, Wyatt Tenhaeff, and Mary Patterson, "Shear Thickening Electrolytes for High Impact Resistant Batteries," *ACS Energy Letters* 2(9), 2084–2088 (2017).
- Brian Shen, Beth L. Armstrong, Mathieu Doucet, Luke Heroux, James F. Browning, Michael Agamalian, Wyatt E. Tenhaeff, and Gabriel M. Veith, "Shear Thickening Electrolyte Built from Sterically Stabilized Colloidal Particles" *ACS Materials and Interfaces* In Press (2018).