Our lab focuses on materials durability in extreme environments for energy, power, and propulsion applications. Current research interests include oxidation and corrosion of ceramics and ceramic matrix composites, high temperature coating development, high temperature water vapor interactions with metals and ceramics, thermochemistry of gaseous metal hydroxides, and oxide defect chemistry.

"Exploring high-temperature chemistry and the use of materials in extreme environments."

Elizabeth Opila
Associate Professor
ejo4n@virginia.edu
www.virginia.edu/ms/faculty/opila.html
Dept. of Materials Science and Engineering
University of Virginia
Charlottesville, VA
434.243.7610
Ultra-high Temperature Materials and their Interactions
Our research focuses on ceramics, which are proposed for use as nose and wing leading-edge materials for hypersonic aircraft. At high-speeds, plasma is formed around the aircraft, resulting in significant vehicle surface temperature increases. We are exposing ceramic materials to ultra-high temperatures to determine how fast they react and degrade. Ultimately, we aim to find ways to improve these ceramic materials as they endure extreme heat.

ZrB₂-containing material systems are under development for use in ultra-high temperature extreme environments, however, they suffer from poor oxidation resistance. We are characterizing ultra-high temperature ceramics created through novel combinations of sample resistance heating and double oxidation exposures while taking advantage of state-of-the-art capabilities in isotopic mapping by Time-of-Flight Secondary Ion Mass Spectrometry.

Ceramic Matrix Composites for Combustion Applications
SiC-based Ceramic Matrix Composites are currently under development for turbine components in propulsion applications due to expected increased efficiencies relative to the currently used superalloys resulting from their lighter weight and potential higher temperature capability. In order to further the use of these composites, we are characterizing deposit induced and internal corrosion mechanisms for SiC-based composites. We are also investigating alternative composite matrix materials which will be more corrosion-resistant.

Gaseous Metal Hydroxide Thermochemistry
Understanding of long term material stability is essential for the development of alternative energy schemes. We are interested in predicting oxide stability for use in a variety of energy applications, including solid oxide fuel cells and solar hydrogen production from water.

RECENT RESEARCH DEVELOPMENTS
• We have demonstrated that short–time high-temperature UHTC oxidation significantly impacts long-term variability in material degradation. Understanding these sources of variability is essential for developing robust life-prediction models.
• A steam jet furnace has been developed that simulates the temperature, gas chemistry, and gas velocity of turbine engines. This capability allows rapid and quantitative testing of materials durability for turbine engine applications.

RECENT GRANTS
• Rolls Royce- Computational modeling and validation of chemical compatibility & recession for rare earth silicate environmental barrier coatings
• DOD/ONR-Hot corrosion of SiC-based ceramic matrix composites

SEAS Research Information
Pamela M. Norris, Associate Dean
University of Virginia
Box 400242
Charlottesville, VA 22903
pamela@virginia.edu
434.243.7683