their temperature-resistance relationship. From the normalized results the optimal collection ratio was expressed in terms of applied voltage and filter mass. We raised the operational voltage from 1.0 to 3.0 V, and we found that the collection efficiency was increased by a factor of five for both theory and experiment.

Toxicokinetics of PBDE-47 in Fathead Minnows *(Pimephales promelas)*. *DANIEL HASKELL (University of California–Santa Barbara, Santa Barbara, CA 93116) IRVIN SCHULTZ (Pacific Northwest National Laboratory, Richland, WA 99352).* Polybrominated diphenyl ethers (PBDEs) are commonly used as flame retardants in many consumer products and reports of their occurrence in fish and humans has steadily increased. In this study, we experimentally measured the uptake, retention and maternal transfer of PBDE-47 in fish. Minnows were orally exposed to PBDE-47 by controlled feedings of brine shrimp (*Artemia sp.*) that previously had been incubated with PBDE-47. Female minnows were given a single oral dose and terminated at selected times to characterize the uptake and tissue distribution of PBDE-47. A separate group of PBDE-47 dosed females were used to study the maternal transfer of PBDE-47 to eggs. The latter experiment paired a dosed female minnow with a control male to induce spawning. My results indicate that PBDE-47 is rapidly and well absorbed from the minnow gastrointestinal tract. Peak blood plasma and carcass levels occurred around 12-24 hrs after dosing although smaller amounts were detected after the first sampling time of 0.5 hr. Measurement of the maternal transfer of PBDE-47 to eggs indicates this is an important elimination route for females, with approximately 11% of the body burden being eliminated in a typical spawn. In contrast, non-spawning females appeared to have a greatly reduced capacity to excrete PBDE-47.

Validity of Observing Fine Root Density Using Minirhizotron Tubes. *JOEY ROBERTS (Middle Tennessee State University, Murfreesboro, TN 37132) DR. RICHARD J NORBY (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* Minirhizotron observation tubes allow nondestructive, in situ, estimates of fine root dynamics in natural ecosystems. All minirhizotron users make a major assumption: that root length measured by the minirhizotron tube is representative of root production at the site. Root production and turnover measurements are important components of C sequestration and are frequently used at many sites, including Oak Ridge National Laboratory's Free-Air CO_2 Enrichment (FACE) facility. This study aimed to answer the question: are there altered root patterns along minirhizotron tubes when compared to root production in the bulk soil? This study took advantage of a unique opportunity to destructively sample unused minirhizotron tubes that have been in place for 9 years at the facility. Fine (=2mm diameter) root biomass density (mg dry weight cm^{-3}) measurements were destructively collected along the minirhizotron tube-soil interface on three tubes and in the adjacent bulk soil. First, intact soil cores were collected by coring straight through the butyrate tube. Correspondingly, soil cores were taken 5 cm away from each tube in the adjacent soil. Sampling was done at a vertical depth of 40 cm. In all, two soil cores were taken per plot for a total of six samples. Soil disks (2 cm by 2.54 cm) were sliced off at the soil-tube interface, and fine-root biomass density was quantified. Results from this study showed that in all three plots, fine root biomass was lower at the tube-soil interface than in the bulk soil. These data suggest that the presence of the minirhizotron tube may be underestimating root density at ORNL FACE.

Vineyard Optimization through Novel Characterization and Cluster Analysis: Applications of Geographic Information Science in Precision Viticulture. *JAMES WOLF (University California–Santa Barbara, Santa Barbara, CA 93106) SUSAN HUBBARD (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* With viticulture and other agriculture comprising a significant portion of the California economy and water budget, accurate and precise information regarding soil and hydrological characteristics is crucial. With regards to viticulture, the science of growing wine grapes, 90% of the United States' wine is produced within California. Furthermore, California is the nations greatest consumer of developed water, with roughly 80% of that water allocated to agricultural production. This research combines a wide array of data collected from both traditional and novel techniques into a single analysis. Traditional data acquisition techniques explored in this project include surveying of topography for elevation, slope, and aspect analysis, soil pit drilling for analysis of soil texture and chemical composition, and Time Domain Reflectrometry. These traditional techniques offer discrete sampling which necessitates interpolation between sample points. Novel techniques, on the other hand, provide more continuous data collection. Such techniques include Ground Penetrating Radar, electromagnetic measurements, Cone Penetration Testing for soil behavior types, and Normalized Difference Vegetation Index. From these data, properties that are important to the production of wine grapes such as soil moisture and texture can be estimated. To manage the data collected, a Geographic Information System was developed. Then the Hierarchical Ordered Partitioning And Collapsing Hybrid algorithm was applied to look for clusters of similar values, with the ultimate goal of delineating management zones within a single vineyard. In this way, a wine grower can optimize production by precisely planning where higher quality grapes will be most suitable for planting. Also, in order to optimize water resource management, water balance simulations can be performed within the defined management zones to explore the impact of different irrigation strategies.

Wind Energy: Changing the Future One Gust at a Time. *SHARLA BOARDMAN (Brigham Young University, Provo, UT 84606) GARY SEIFERT (Idaho National Laboratory, Idaho Falls, ID 83415).* This project was focused on improving the possibilities of wind power in southeast Idaho. The main objectives were to set up anemometers, calculate wind data, create a kiosk proposal for a local wind farm, and accumulate lesson plans and activities for the Idaho National Lab (INL) wind outreach program. In order to accomplish the objectives the team went into the field to set up an anemometer tower. An anemometer is an electronic device that measures the constant wind speed for one month's time. Over a years time the team would return to the site each month to replace the chip and collect the previous month data from the chip. The data was then recorded into a program called Symphonie Data Retriever which uploaded the information to the INL website. The next step in the project was to take this knowledge about anemometers and correlate it with lessons and activities for elementary and secondary education students. These lessons provided students the basic concepts about wind power and renewable energy. These concepts are found in most state education standards. The Outreach website now houses lesson plans for grades K-12. A college lesson plan curriculum is currently under development. Another focus for this summer included the proposal for the Wolverine Creek Wind Farm. This kiosk includes design plans for a visitors' information center, as well as the information that would be most beneficial to the viewers. The idea for the kiosk was presented without any design or cost constraints. Initially, a brainstorming session was held to determine possible structure layouts for the informational area. Once several plans were formulated, cost analysis as well as feasibility was required to compile and create a professional proposal. The Outreach website provides critical wind energy information to students at all educational levels. Once the students obtain this wind energy education, they are better prepared to make future decisions that affect the environment.

General Sciences

An Analysis of Chlorine Gas Release. *KARA BROWN (University of California–San Diego, La Jolla, CA 92092) GEORGE FULTON (Lawrence Livermore National Laboratory, Livermore, CA 94550).* Chlorine is an extremely reactive and harmful gas that can cause a myriad of health problems within seconds of exposure. This report is an analysis of current chlorine safety regulations in place at Lawrence Livermore National Laboratory for Building 153. It was found that the rapidity at which usable amounts of chlorine gas could be released into the main workspace of the building that the emergency response alarm for a leak needed to remain active. The calculations go through a series of different possibilities including the concentration of chlorine gas with multiple size cylinders, the difference that ventilation makes, and the amount of time it would take the ventilation to get the concentration of chlorine gas down to different airborne exposure standards such as the IDLH, STEL, 8-Hour TLV, or Mean Odor Threshold.

***Arc Flash.** *YEVHEN RUTOVYTSKYY (Three Rivers Community College, Norwich, CT 06360) SWAPNA MUKHERJI (Brookhaven National Laboratory, Upton, NY 11973).* Analyzing BNL electrical distribution system. Determine the incident energy, boundary requirements, and the personal protective equipment necessary tin order to minimize the possibility of electric shock to personal. All the calculations are done by using PTW (Power Tools for Windows) software and based on measured data or information, obtained from the manufactures labels (such as: operating voltage, breaker size, size of the wire etc.) After completing this project we expect to come up with a universal label that will be posted on all electrical equipment that exists at BNL. New label will contain the name of the panel, warning statement "Arc Flash Hazard!!!" and category PPE (Personnel Protective Equipment).

Assessing the Impact of Aerosols on the Radiation Budget in the Sahel Using the Shdompp Radiative Model. *NIMISHA GHOSH ROY (University of Washington, Seattle, WA 98006) TOM*

ACKERMAN (Pacific Northwest National Laboratory, Richland, WA 99352). To understand Earth's dynamic climate system, scientists are developing global climate models. Currently there are various climate models that scientists are continuously trying to understand and refine. Current difficulties include the ability to correctly include the effect of aerosols and clouds in global climate models. The purpose of this project is to work on calculating the effect of aerosols (particles in the atmosphere) on the Earth's radiation budget (the balance of incoming and outgoing solar radiation). This project focuses on the effects of aerosols in the Sahel (south of the Sahara Desert) with hopes of refining the way global climate models currently model the Sahel and similar regions. The instruments used are part of the Department of Energy's Atmospheric Radiation Measurement Program's mobile suite of instruments located in Niamey, Niger. The Sky Radiometer, Total Sky Imager and Micropulse Lidar were used to identify periods of clear skies on a time scale of fifteen minutes. Clear sky sets of data were critical because the presence of clouds in the data set would introduce too many variables. Various atmospheric properties were collected from a variety of instruments (also at Niamey, Niger) over the same periods of clear skies. Data used were from January 1–31st, 2006. The data was put into the SHDOMPP (Spherical Harmonics Discrete Ordinates Model, Plane-Parallel Version) Radiative Transfer Model. The model was run with two scenarios: 1) Clear Skies with Aerosols and 2) Clear Skies without Aerosols. Comparing the SHDOMPP model results with observed data from ground instruments provides a measure of the accuracy of the model. Initial results show a 1–5% agreement between modeled and observed calculations of total down welling shortwave flux. The two model runs (with and without aerosols) were compared to each other to understand the effect of the aerosols. Initial results show the presence of aerosol lowers the total down welling shortwave flux by 32–120 w/m^2. Problems with the treatment of some input parameters have been identified. The next step in developing an understanding of the effect of aerosols will involve refining the assumptions and parameters input to the SHDOMPP model.

Focal Mechanisms and Stress Axes of Microearthquakes in Southeastern Washington State. *STEFANY SIT (Lawrence University, Appleton, WI 54911) ALAN ROHAY (Pacific Northwest National Laboratory, Richland, WA 99352).* The Hanford Seismic Network combined with the Eastern Washington Region Network covers eastern Washington State with forty-one seismograph stations. Routine analysis monitors and locates local seismic events dominated by shallow depth microearthquakes. However, regular study does not include investigations into the mechanisms of earthquakes. This report uses seismograms from 2000 to 2006 to develop constraints on fault and auxiliary planes of seismic activity occurring in southeastern Washington State. Through the proper identification of planes, the principal axes of stress can then be extrapolated. Using a SUN system and Focal2 software, focal mechanisms were developed according to the procedure provided by Oppenheimer (1996). A significant portion of the mechanisms showed a general maximum compression in the north-south direction with a low angle of plunge. The axis of minimum compression showed varying orientations with no conclusive pattern. These results are in agreement with previous studies done in the area and show no deviance from the historical pattern.

Inquiry-Based Learning at Its Best. *SARAH BAUM (Lesley University, Cambridge, MA 02138) MARY CONNOLLY (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* The Lawrence Hall of Science (LHS) is one of the leading forces in the inquiry-driven, direct experience approach to science and mathematics instruction for grades K-12. LHS has developed several inquiry-based curriculum projects that are used throughout the United States. This public science center also provides educational exhibits and classes, year-round outreach programs, as well as diverse summer camp programs for children of the region. The investigative approach stems from human beings' natural curiosity to explore what is seen on a daily basis. This strategy when applied to a classroom helps students connect concrete ideas to their own experiences through open-ended investigations and discussions. My goal throughout the summer was to observe how instructors use guided inquiry techniques with a variety of age groups to delve into life, physical, and earth science. My research reflects an exploratory sample of age groups and content areas. Working alongside LHS instructors has allowed me to study inquiry-based education by observing, comparing, analyzing, and applying themes and elements central to the process.

Qualitative Testing of Social Network Analysis Biowarfare Taxonomy: An Analysis of LLNL Open Source Publications. *LIRAN GOLDMAN (University of California–San Diego, La Jolla, CA 92093) DEBORAH YARSIKE BALL, DALE K. BREARCLIFFE (Lawrence Livermore National Laboratory, Livermore, CA 94550).* The Dynamic Network Engineering Group takes a network-centric approach to discover and characterize organizational expertise and relationships of state and non-state actors intent on creating and using weapons of mass destruction (WMD). This approach utilizes a taxonomy that can identify and extract key actors from large, unstructured data sources. In this project, a taxonomy was developed and tested on a known entity: Lawrence Livermore National Laboratory (LLNL). The goal was to discover and qualitatively describe the results of a specific taxonomy when combined with the dynamic network analysis methods. The data used in this test analysis include a list of Livermore Laboratory employees who have a pager assigned to them, online versions of LLNL's Science & Technology Review (S&TR), and a potential biowarfare taxonomy. After the S&TR issues were downloaded, the data were uploaded and processed in Automap, a program capable of extracting and analyzing computer based text by creating links among words then constructing a network. Next, the words of interest were extracted from the S&TR articles, and evaluated in Organization Risk Analyzer (ORA), a program capable of statistically analyzing dynamic networks. The analysis completed by ORA on this dataset revealed some key findings: the years 2003 and 2004 were prominent for biology related publications. Also, pathogens and anthrax were consistently the top areas explored. Follow-up analysis of these results indicates that this process is successful at singling out pertinent actors, but the results should be viewed with caution. A few drawbacks include Automap's failure to extract variations of words the program is instructed to locate. Additionally, not all of the relationships established by Automap are valid due to its inability to distinguish between unrelated, yet adjacent articles. Furthermore, reporters who wrote the publications used in this test case became part of the data set. Also, the inclusion of projects and people is not a complete representation of ongoing research at LLNL. This latter issue is somewhat mitigated when examining external organizational expertise and relationships because the publications assessed are usually authored by the researchers themselves. These matters will be considered when applying this process to other datasets.

***The Effect of Fire on Soil Carbon Storage in a Prairie Ecosystem: Applications to Global Climate Change and Ecosystem-Climate Feedbacks.** *RYAN SMITH (California State University–Fresno, Fresno, CA 93740) MARGARET TORN (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* The increasing concern around the topic of global warming is reason to assure climate change models be accurate. A potentially important omission from current models is CO_2 feedbacks between climate and soils. Natural fire and managed fire both play an important role in maintaining the prairie ecosystem. If warming increases the frequency of fire it will be important to know the effect fire has on the storage of carbon in soil. The goal of this project was to investigate the effect of fire on soil carbon stocks in a prairie of the Southern Great Plains. Our null hypothesis was: no change in carbon content of grassland soil due to the fire treatment. The alternative hypothesis was that carbon content of the soil will decrease due to the treatment of fire. The USDA Grazing Research Laboratory in Oklahoma collaborated in this project and provided soil samples for analysis. Ten soil cores, 1 meter deep, were collected from two adjacent prairie fields in March 2005. Shortly after collection, the north field was treated with fire while the south field was left unburned to function as the experimental control. In August 2005, 10 more cores were collected from each of the two fields. Each core was divided into 10 cm depth increments from 0–50 and 25 cm increments below that, to look at the change in carbon content with depth. One half of the core was used to determine bulk density. The other half was used to test for carbonates and determine carbon content. No core tested positive for carbonates. For carbon analysis, the soil was homogenized and roots were removed. The carbon analysis showed that the content of carbon decreased with depth and that the greatest variability among cores was in the top 10 cm. Between March and August, the south field (unburned control) lost, 0.31 kg Carbon/m^2 ($p < 0.14$ for the difference). In contrast, the north field showed an average total carbon stock loss of 1.1 kg Carbon/m^2 after the treatment of fire. The loss of soil carbon in the burned field was highly significant (one-tailed $p < 0.034$) Assuming that the lost soil carbon was released to the atmosphere as CO_2, these results suggest that there could be a strong positive feedback effect if warming increases fire frequency in prairie. Continued research on the rates of inputs and outputs of carbon into the soil-and the effect of fire on them-needs to be done to make whole conclusions.

The Laboratory Assessment Worksheet—A Risk Comparison of Biological and Chemical Hazards in the Laboratory. *REBECCA WILLIAMSON (University of Virginia, Charlottesville, VA 22556) GERALD SCHWEICKERT (Lawrence Livermore National Laboratory,*

Livermore, CA 94550). Biological hazards and chemical hazards are commonly found within the same project at Lawrence Livermore National Laboratory (LLNL), however no established system currently exists to do a comparative analysis of the degree of implementation of safety controls for both types of hazards. A Laboratory Assessment Worksheet was created to devise a way to quantitatively compare the hazards, controls, and the degree of risk management actually present. Four numerical values—a biological hazard score, a chemical hazard score, a biological control score, and a chemical control score—were calculated to accomplish the comparison. The worksheet utilizes the Centers for Disease Control and Prevention's biosafety levels as a score for biological hazards; Sax's Dangerous Properties of Industrial Materials hazard ranking in combination with an exposure potential evaluation for the chemical score; and a percentage of a standardized list of controls for the control scores for both hazards. Once scores for each of the four categories are tabulated, the ratio of the hazard score to the control score can be used to decide whether the controls are appropriate for the particular hazard, i.e., the degree of risk management. Upon further development this worksheet will become a unique tool for the Hazards Control Department at LLNL because it will serve as an initial screening tool with the ability to compare biological and chemical hazards in a single experiment as well as biological and chemical hazards across multiple experiments.

Material Sciences

A Novel Approach to Estimating Thermal Conductivity. *GORDON WU (University of California–Berkeley, Berkeley, CA 94720) TIM KNEAFSEY (Lawrence Berkeley National Laboratory, Berkeley, CA 94720).* Scientists at Lawrence Berkeley National Laboratory (LBNL) are currently researching natural gas recovery from gas hydrates in hopes that this will one day become a viable source of energy. Natural gas hydrates are water crystals located below permafrost and submarine environments that contain methane gas. Knowledge of heat flow through the hydrate-bearing reservoir must be understood and thermal conductivity is a fundamental property of a material that indicates its ability to conduct heat. The technique for estimating thermal conductivity calls for applying a temperature changes and using thermocouples to accurately measure the rate of temperature change. The thermal data were analyzed using Microsoft Excel and iTOUGH2. The program iTOUGH2 computes a best-fit to our measured data by optimizing the thermal conductivity through automatic model calibration. ITOUGH2 estimates the thermal conductivity based on previous output values and given parameters. The four materials used were dry sand, polyvinyl chloride (PVC), high density polyethylene (HDPE) and Pyrex borosilicate glass, and were chosen because they have thermal conductivities close to that of hydrate bearing sand (2.7 W/m K). Good matches were obtained between the simulations and the measured data showing the validity of the technique. It is important to realize that the substances that we were using can vary in thermal conductivity depending on the temperature, the porosity of the particular substance, and the composition of the sample. Now that the technique is validated, it can be used in other experiments to measure thermal conductivities.

Atomic Layer Deposition of Tin (IV) Oxide and Indium Tin Oxide Using Tetrakis(Dimethylamino)Tin Precursor. *DAVID BAKER (University of Illinois at Urbana Champaign, Urbana, IL 61802) GREGORY KRUMDICK (Argonne National Laboratory, Argonne, IL 60439).* Thin films of tin oxide were deposited on silicon wafers (001) and glass by Atomic Layer Deposition (ALD) using alternating pulses of Tetrakis(Dimethylamino)Tin and an oxidizing precursor. Doping tin oxide films with various reagents, such as indium, can create smooth, optically transparent and conductive coatings with applications in solar cell, gas sensor, and flat panel display technologies. Using deposition temperatures between 100–400°C, and exposure times ranging from 0.5 to 8 seconds, growth of a film was evident on Al2O3 coated substrates. For the silicon and glass substrates, measurements from the spectroscopic ellipsometer showed the thickness of the film increased with temperature and increased linearly with the number of cycles (maximum of 1.5 Å per cycle) during the ALD growth. At lower temperatures, extending the exposure times of each precursor demonstrated a self-limiting reaction. Growth at higher temperatures did not demonstrate a self-limiting reaction. This precursor was also used to create Indium Tin Oxide (ITO) films also by ALD. As evident from 4-point probe resistivity measurements, tin oxide and ITO films are excellent conductors with good optical transmittance. Characterization of the films was furthered by x-ray diffraction (XRD), x-ray photoelectron spectroscopy (XPS), x-ray florescence (XRF), and scanning electron microscope (SEM). Tetrakis(Dimethylamino) tin precursor demonstrated consistent ALD growth on glass and silicon surfaces coated with Al_2O_3.

Characterization of Nano-Particles in Mesophase Pitch Derived Graphite Foams. *JENNIFER MUELLER (Virginia Polytechnic Institute and State University, Blacksburg, VA 24060) JAMES KLETT (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* The addition of nano-particles to a raw material can significantly alter the structure and therefore properties of a material. A characterization study was conducted to explore the effects of nano-particle additions on graphite foam, a material that exhibits very high thermal conductivity and low density. Carbon nano-particles were added to mesophase pitch in varying amounts and processed to create graphite foam. Image analysis was conducted on each sample by using an optical microscope, Scanning Electron Microscope (SEM), and Transmission Electron Microscope (TEM). Other analyses included density measurements, compression tests, permeability tests, and flash diffusivity tests. Results showed that there were overall trends of decreasing density, thermal conductivity, and strength with an increasing amount of carbon nano-particles, but the permeability increased. Through optical image analysis, it was determined that the ligament size of the graphitic matrix decreased and that there was a significant disruption of graphitic plane alignment with greater additions of carbon nano-particles. Additionally, it was seen with the SEM that the number and size of open pores increased with an increasing amount of carbon nano-particles. Overall, the decreased ligament size and disruption of graphitic alignment explains the decreased strength and thermal conductivity, respectively. Also, the addition of the nano-particles increased the open porosity and, therefore, increased the permeability of the foam. As a result, the graphite foams characterized through this study are suitable for applications where higher permeability foams are desired. Since the mixture with the greatest amount of nano-particles had the highest permeability, a further study should be conducted to determine what mixture results in the maximum permeability of the graphite foam without a significant loss in thermal and mechanical properties.

Characterization of Sub-diffusion within Benard-Rayleigh Advective Cells by Examination of a Velocity Field with Additive Noise. *MARSHA LAROSEE (University of Michigan, Dearborn, MI 48128) BEN CARRERAS (Oak Ridge National Laboratory, Oak Ridge, TN 37831).* Normal diffusion worked out by Einstein and Taylor is modeled by averaged particle 'Brownian motion' such that a given particle's motion is determined by *random* collisions with surrounding particles. Less well understood is the subject of anomalous diffusion, which is studied in many fields where diffusion influences the system (e.g., heat, fluids, chemical kinetics). The distinction between normal diffusion, a random mechanism and anomalous diffusion, that is a mixture of *random* and *deterministic* processes, is the time scale at which the transport occurs. Both diffusion and anomalous diffusion follow a power law relation $< \Delta r\, s > 1/s \approx t\, q(s)$, where $q(s) = 1/2$, $< 1/2$, $> 1/2$ for diffusion, sub-diffusion, and super-diffusion. Thus, sub-diffusion and super-diffusion scale with time differently than random motion predicts. In order to study sub-diffusion a deterministic model must be used while adding randomness, or noise to the system. A model referred to as the random walk with pauses or trapping events was investigated in order to characterize sub-diffusion in a fluid system. The system that was studied is an array of Benard Rayleigh advective cells where the velocity fields cause 10,000 tracer particles to circulate within a cell. Noise added to the velocity field causes diffusion between cells. Moments of the displacement were calculated as a function of time while varying the frequency and magnitude of noise in order to magnify the region where sub-diffusion is observed. Frequency of the additive noise extended the time frame in which sub-diffusion was observed and appears to extend the time frame non-linearly. Moments of the displacement show that the diffusive exponent q(s) is the same for all higher moments which indicates scale invariance, or q(s) = constant. This property is characteristic of both anomalous and normal diffusion. The exponent observed q(s) ~ 0.4, was larger than the typical exponent of sub-diffusive systems q(s) ~ 1/3. The reason for this is undetermined but may indicate an influence of normal diffusion within the system and future investigation is planned.

Composition of Stainless Steel Slurries for Enhanced Structural Support of the TuffCell. *LAURA JANE ELGASS (College of DuPage, Glen Ellyn, IL 60517) J. DAVID CARTER (Argonne National Laboratory, Argonne, IL 60439).* The "TuffCell" is a bipolar plate-supported solid oxide fuel cell that produces electrical power by the galvanic combination of oxygen with hydrogen or other fuel. The SOFC anode support must be both conducting and porous. Porosity is required to ensure that hydrogen gas can flow through the anode support. SOFC anode supports have traditionally been composed of nickel, but the