Mar 8th, 9:59 AM

07. Engineering

Southwestern Oklahoma State University

Mathematics and Science.Engineering.01

YuhaoJiang

University of Central Oklahoma

MR Image Evaluation using Perception Models

Magnetic Resonance Imaging (MRI) is a fast developing image modality. It is advantageous to other imaging methods from many sides such as radiation-free, excellent soft tissue contrast, and etc. Human perception model, which includes human visual system properties, can provide quantitative values for the assessment of image quality. In this study, we developed a more advanced and specialized computational human perception model to assess magnetic resonance images. This model is based on the idea to associate the perceptual difference model (PDM) and detection models. A modified PDM channel structure was implemented in the detection model. A detectability value was determined by the detection model. The model can quantitatively evaluate image quality with the improved accuracy. We anticipate that the proposed model can not only use detection of a low contrast lesion as a measure of image quality, but apply to other circumstances where detection is an inadequate measure such as interventional MRI and fast MR imaging.

Mathematics and Science.Engineering.02

JosephPuskas, MelvilleVaughan

University of Central Oklahoma

Modeling and Simulation of Pipeline Embolization Devices Effects on Fluid Flow into an Aneurysm

This research demonstrates the effects of various Pipeline Embolization Device (PED) designs on the blood flowing into an aneurysm. PEDs are used to reduce blood flow into an aneurysm and therefore allow for the blood vessel to heal. Finding optimal designs for the pores in a PED could help improve aneurysm treatments. In order to carry out this research 3-D models of blood vessels were made with the PED designs inside of them and then numerically modeled in COMSOL. The blood vessel model has a diameter of 4 millimeters, a side branch with a diameter of 1.5 millimeters, and an aneurysm with a height of 15 millimeters. These dimensions were taken from a real patient’s aneurysm. The simulations were run using physiologically realistic pulsating pressure and velocity boundary conditions ranging from 80 to 120 mmhg and from 0.2 to 0.56 meters per second respectively. The results of each simulation are able to be directly compared to each other because the only variable changed between the simulations was the size of the pores in the PED design. The effectiveness of different stent pore sizes was obtained by comparing the flow profiles, velocities, and shear stresses inside of the aneurysm for each of the different PED designs. The results of this study show a linear change in the velocity of blood inside of the aneurysm as the size of the holes decreases. These simulations are the first step in determining an optimal design of PEDs for reducing blood flow into an aneurys

Mathematics and Science.Engineering.03

HelgaProgri

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Effect of immobilization of fibronectin and collagen on the cellular functions of poly-&[epsilon]-caprolactone

Fibronectin (FN) contains several active sites, known as the heparin-binding domains, collagen-binding domain, fibrin-binding domain, and cell-binding domain, that serve as platforms for cell anchorage. [1] The goal of this study was to evaluate the effect of immobilization of collagen and plasma fibronectin with polycaprolactone (PCL) nanofiber membrane (NFM) on the cellular functions of PCL NFM.The results (Fig. 1c and Fig. 1d) show that the individual immobilization of CG and FN on PCL NFM has no adverse effect on osteoblast cell adhesion and proliferation of PCL NFM, although a significant increase of cell adhesion was observed for FN-PCL-NFM when compared to PCL NFM ($p<0.05$). A significant improvement of cell adhesion and proliferation was observed for FN-CG-PCL NFM in comparison to PCL NFM ($p <0.01$). This is due to the fact that higher cell functions were created via better cell signaling arising from the cell–cell contact and the cell-NFM components in the case of FN-CG immobilized PCL NFM compared to PCL NFM.

Mathematics and Science.Engineering.04

ErinDrewke, GangXu

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Biomechanical Characterization of Engineered Dermal-Equivalent Tissue

The purpose of this study is to probe and quantify the mechanical tension generated in the fibroblast-populated collagen lattices. In this study, we created tension-maintaining dermal equivalents by co-culturing human dermal fibroblasts with type-I collagens in relative low, medium and high concentrations. Polymerized collagen lattices were supported structurally by plastic mesh rings. TGF-&#55349;&#57085; was added to some lattices to study its effects on tension generation. The cultures were incubated in a CO2 incubator for 7 days to allow the lattices to develop. After incubation, the generated mechanical tension in these dermal equivalents was probed by removing a small circular section (2-mm in diameter) from the tissue with a biopsy punch. The expansions of these induced wounds were recorded and measured at various time points. We found that the circular wound area expanded more quickly the lower the collagen concentration in the lattices, and more slowly the higher the collagen concentration, suggesting that there is considerable level of mechanical tensions in the collagen lattices. In addition, the induced wounds in TGF-β treated lattices showed quicker and larger expansion than the control, which indicates more tension generated in the presence of TGF-β. The results would indicate that higher collagen concentration impedes the tension generation in the tissues.

Mathematics and Science.Engineering.05

RanjanSinghal

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Synthesis of Two-Dimensional Hexagonal Boron Nitride by Chemical Vapor Deposition

Two-dimensional hexagonal boron nitride (2D hBN) is a single - atom thick layer (monolayer) of alternating boron and nitrogen atoms, which is of great interest and potential due to its excellent electrical, optical, and mechanical properties and isostructural to graphene. In order to fully utilize the potential of 2D hBN, wide area processing of high quality 2D hBN is of utmost importance. As of now, chemical vapor deposition (CVD) is the most promising method to synthesize 2D hBN because it provides great control on the thickness of deposited films (number of layers) and is the best candidate for industrial scale-up processes. Therefore, a CVD system was designed for synthesis of two-dimensional hexagonal boron nitride with low (UHV, LPCVD) and atmospheric pressure (APCVD) operation capabilities and solid and liquid precursor delivery system. This customized CVD system is also capable of synthesizing other 2D materials like graphene and molybdenum disulfide since it can incorporate different types of precursors and reaction gases. This presentation reviews the state-of-the-art research on 2D materials, especially for hBN and explores the CVD aspects of hBN synthesis with a specific focus on the designed CVD reactor system and its components. Preliminary results on the synthesis of 2D hBN will also be presented.

Mathematics and Science.Engineering.06

DarianLincoln, MelvilleVaughan

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Biocompatibility and Biodegradation Analysis for a Flow Diverter

Fine-meshed flow diverters have become a promising and efficient endovascular treatment to cure aneurysm by controlling blood flow into the aneurysm. These fine-meshed flow diverters are made from micrometer scale metallic wire. However recent report shows that permanent placement of metallic wire is a source of late thrombosis, stentonis and other delayed vascular complications. A fine-meshed flow diverters based on a biomaterial that would reduce those risks by completely absorbed by the body. The objective of this research is to evaluate and study biological properties, biocompatibility, and biodegradation of two candidate polymers; polylactic acid (PLA, a thermopolymer), and a photopolymer. Flow diverters made from PLA and a photopolymer were tested with multiple cellular experiments for compatibility and evaluated the degradation rate. Human dermal fibroblasts cells were used to quantify cell performance such as proliferation, differentiation, and adhesion on the flow diverters. Results show that cell growth, proliferation, differentiation, and adhesion are positive compared to a control in cell culture dish without flow diverters. For degradation study, both flow diverters were soaked in a phosphate buffer solution over 2,4, and 6 week periods. The degradation rate of photopolymer was found to be 1.8% for 2 weeks, 6% for 4 weeks, and 8% for 6 weeks. These results shows that the candidate material can be used for making fine-meshed flow diverters for aneurysm treatment.

Mathematics and Science.Engineering.07

AliciaJohn

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Melt Electrospun 3D Scaffold

Melt electrospinning is a processing technique to produce fibers and fibrous structures from polymer melts in the range of nanometers to few micrometers. This advanced technique is used to design and build pre-determined porous scaffolds, which depends on the instrument parameters and solvent properties: fiber diameter, uniformity of the fibers, solution viscosity, flow rate, tip to collector distance, ambient parameters. The main limitations of the regular electrospinning process lies in the fiber diameter in the undesired range and formation of beads or pores in the structure due to the solution viscosity, making fibers non-uniform. My research is to develop a modified melt electrospinning system using Newport actuators for controlling the scaffolds in the three dimensions within the range of ten microns. Selecting a suitable biocompatible, biodegradable chemical solution, also determines the feasibility of the system. Different solutions such as Calcium Phosphate cement (CPC), Polycaprolactone (PCL) with acetone were tried with various concentrations, the viscosity of the experimental solutions were tested using the Bohlin Rheometer. Arduino programmed stepper motor syringe pump system is used to control the ejection of fluid to maintain constant flow rate, preventing the formation of any non-uniformities. The whole system is enclosed for optimal performance of the UV light, accelerating the normal curing time of the solution.

Mathematics and Science.Engineering.08

AshleaSartin

Oklahoma State University

Mathematical Modeling of Mesangial Matrix Expansion in Diabetic Kidney Disease - Ashlea Sartin and Ashlee N. Ford Versypt

Diabetes is the leading cause of kidney disease. About 1 out of 4 adults with diabetes has kidney disease. The kidney is supposed to filter wastes and extra water out of the blood stream to produce urine. When the kidney is damaged, it cannot filter blood like it should, which leads to waste build up and excess water in the body and eventually to death. One of the key cell types damaged in the kidney is mesangial cells. Experiments have shown multiple chemical pathways that change mesangial cells in diabetic kidney disease (DKD). It is challenging to describe how these chemical pathways interact with each other in mesangial cells over time. I have used mathematical modeling of differential equations to represent the chemical pathways in mesangial cells that are known to be affected by DKD. I have combined the separate pathways into a comprehensive systems biology model that can consider the interactions between pathways and between multiple mesangial cells in the kidney filtration barrier. I will present model results for conditions that lead to expansion of the mesangial tissue (cells and extracellular proteins) during diabetic hyperglycemia.

Mathematics and Science.Engineering.09

ClaireStreeter

Oklahoma State University

Mathematical Modeling of Nephrin Loss in Diabetic Kidney Disease

Diabetic kidney disease is the leading cause of kidney failure. The job of the kidneys is to filter the blood. However, when the kidneys are damaged, the filtration system is less efficient. The kidney has many different cells and areas. In this project we focused on podocyte cells, which compose the outer filtration barrier. In between podocyte cells, a protein called nephrin connects the podocytes like Velcro. The blood is filtered through this area to excrete waste and excess water. Diabetes can cause the nephrin to lose its Velcro abilities causing it to disconnect from the podocyte cells and be excreted in the urine. The loss of nephrin causes the mountain and valley landscape of the podocytes and the gaps between them to become distorted. The damaged filtration system allows not only the waste materials to be removed but excess proteins are excreted into the urine. Diabetic complications can cause the nephrin to lose the Velcro ability and be excreted. We will present an empirical model for predicting category of proteinuria (protein in the urine) based on loss on nephrin expression using human biopsy data for Type 2 Diabetes patients. The model relates the % of nephrin lost to the mRNA of nephrin and the urinary protein concentration. This noninvasive modeling research provides quantitative guidance for the threshold where nephrin loss causes long-term damage to the kidney clinically detectable by the presence of protein in the urine.

Mathematics and Science.Engineering.10

Ka HeiChan

University of Central Oklahoma

In-car Life Detector

This paper studies about building a device that saves human-being who is trapped in a car with methods of calculating life indicators, and signal analysis, and Internet of Things (IoT).

Written by Ka Hei Samuel Chan and Dr. Nescreen Alsbou.

Mathematics and Science.Engineering.11

KhaledSallam, AndrewWilliamson

Oklahoma State University

Human-Powered Desalination Unit

The objective of this research is to design a human-powered desalination unit that can provide safe drinking water for a typical household in developing countries. Currently more than 800,000 children younger than 5 years die every year from diarrhea diseases, which are mainly (>80%) caused by unsafe drinking water and lack of sanitation. The hypothesis of our study is that a human-powered machine operating on a Mechanical Vapor Compression (MVC) cycle can provide economically- and technologically-affordable drinking water without the use of expensive RO membranes. Thermodynamic analysis for human-powered MVC cycle with minimized pressure difference, and small surface area is conducted. The design space included the following limitations: (i) only one compressor and only pump could be used, (ii) evaporation mass ratio was less than 0.7, and (iii) the water had to reach the minimum temperature required to inactivate bacteria, viruses, and protozoa. The effects of the concentration of salt in the waste brine were considered. The flow rate of clean water generated was calculated as a function of the required heat exchanger surface area; the primary cost factor in the design; as well as the compressor isentropic efficiency. The point of maximum efficiency in term of mass flow rate per unit surface area was calculated.

Mathematics and Science.Engineering.12

EileenHernandez

University of Central Oklahoma

Determining the optimal parameter to produce Nano-fiber on a drum collector

The goal of my research is to produce a nanofiber plot using a rotary drum. Unlike normal fibers, nanofibers are fibrous, light weighted with a diameter of 100 nanometers or less. It is produced by combining a polymer such as Polycaprolactone (PCL) and a solvent like acetone. There’s different ways to collect fiber, however the process we use is called the electrospinning method. It consists on using electric charge to attract threads of the polymer solution. For my project, I will be using a syringe’s needle and a metal rotating drum to serve as charging ends where the electrospinning method will take place. The variations of the nanofiber are affected by the rotations of the drum, the flow and release of the polymer substance and the distance between the needle and the drum. The syringe is controlled by a syringe pump which is programed to push at a specific rate. The optimal parameters consist on having perfect alignments of the fibers in a parallel pattern. Once the PCL fiber is produced, we collect it from the drum, and observe it through the Scanning Electron Microscope (SEM). The overall outcome of my project is to built a custom made system that adapts to the production of a desired pattern of nanofiber.

Mathematics and Science.Engineering.13

PadmanapanRao

Oklahoma State University

Crack Healing in Glass and Glass - Ceramic Composite for Solid Oxide Fuel Cells

Demand for energy consumption is ever increasing. The rapid urbanization has facilitated access to power and transportation to a vast majority of population. To maintain current demand and fulfill the future need alternative methods of power generation with highest efficiency is necessary to avoid negative impact of excessive use of fossil fuels. One such alternative technology is solid oxide fuel cell (SOFC). However, one of the major limitations in the development of solid oxide fuel cell’s long term operation, under thermal cycle and high stack load, is the fabrication of a stable sealant which can maintain the hermeticity of the stack and avoid electrical shorting of the cell component. Sealant made out of glass are preferred since it offers inertness, ability to tailor the coefficient of thermal expansion (CTE) to match with other cell components, interfacial stability, high electrical resistance and wettability with the adjoining surface to maintain the stacks hermeticity over a prolonged operation. However, glass and glass ceramics are susceptible to cracking due to their brittle nature when the fuel cell is under thermal transient or even due to slight CTE mismatch with other cell components. This issue can be addressed if the glass maintains its vitreous property thereby facilitating crack healing at cell operating temperature. The effect of temperature, time and composition on crack healing kinetics in glass and glass-ceramics will be discussed and presented.

Mathematics and Science.Engineering.14

PadmanapanRao

Oklahoma State University

Robust Lithium Ion Batteries for Electric Vehicle

With their high energy density, long cycle life and variable charge–discharge rates, rechargeable Li-ion batteries are preferred to power electric vehicles by car manufacturers. However, the use of liquid electrolyte in these batteries can lead to fires and limit the performance due low thermal stability, decomposition and formation of dendrites leading to shorting. These issues are addressed by using solid state electrolyte in addition to improving safety and durability. The most studied and promising solid state electrolyte is Garnet-type $Li_7La_3Zr_2O_{12}$ (LLZO). Current challenges faced by an all-solid-state electrolyte are optimum processing conditions to achieve high density, doping and understanding the nature of interface formed between solid electrolyte and the electrodes. The state-of-art developments in the solid electrolyte along with preliminary results in processing of electrolyte will be discussed and presented.

Mathematics and Science.Engineering.15

AninditaDas, kylelevy

University of Central Oklahoma

Smart Cities Design of an Intelligent Network Using Existing ODOT ITS Technological Infrastructure on Current Oklahoma City Metro Highway.

Highway travel is a constant that is present in the daily lives of a vast majority of the public. Active measures have been developed and are on-going in order to improve the safety of the driving public. Vehicle to Vehicle (V2V) communication has been developed for the use in these active measures. The Oklahoma Department of Transportation has developed a system using V2V for real time data collection. The V2V system can be used in conjunction with smart and or self-driving vehicles. The vehicles have enclosed sensor systems that act to either take action to avoid a potential collision or warn the drivers to take the actions on their own. A prototype will be built to allow us to simulate driving scenarios on a highway and various algorithms for the collision avoidance. This will be accomplished by following the four deliverables: (1) design and implementation of sensor system, (2) analyze and design algorithms for collision avoidance, (3) analyze and implement data transmittal protocols for wireless communication, and (4) generate simulation of vehicle to vehicle network on a real highway system.

Mathematics and Science.Engineering.16

KhaledSallam, MuhammadRaza

Oklahoma State University

Eliminating Spray Drift of Flat Fan Nozzle

The objective of this research project is to eliminate the spray drift caused by crosswind. Spray drift is an important problem for the agricultural industry. Some herbicides (e.g. Dicamba) can cause serious damage if it drifts to nearby crops that are not genetically modified to withstand those herbicides. Our hypothesis is that the nozzle geometry and the injection angle can be actively/passively controlled to compensate for the crosswind. The present experimental setup consists of a commercial spray injection system with three different nozzles. The spray can be injected at different angles in the test section of a subsonic wind tunnel with a maximum air velocity of 60 m/s. The instrumentation consists of a pitot-static tube and an inclined manometer to measure the air velocity in the wind tunnel, a back-light illumination system, and a high-resolution camera. The spray images were analyzed using ImageJ software. The measurements include the breakup regime transitions, the droplet sizes, and the droplets trajectory as a function of the wind speed and the injection angle. The current results show that the crosswind modifies the primary breakup mechanism from sheet breakup regime (i.e. thinning and fragmentation of the liquid sheet into ligaments) to bag breakup regime (i.e. the formation bags along the downstream side of the liquid sheet) resulting in smaller drop sizes and an increased drift flux. Techniques to eliminate the bag breakup regime are presented.

Mathematics and Science.Engineering.17

CarlosPalou

University of Central Oklahoma

Platelet Activation Mechanism in Microchannel Networks

Activation of platelet is the primary response to the scar or inflammation of blood vessel and trigger clotting, thrombus formation and other repairing mechanism. However vascular abnormality such as stenosis can cause uncontrolled activation cause various vascular diseases. The objective of this research is to determine correlation platelet activation with various fluid dynamic parameters and thrombus formation in microchannel network. PDMS mcirochannel network with different width and depth was fabricated using photolithographic process and plasma bonding. Microchannel network mimic Willis circle and various flow conditions including steady and time dependent pulsating flow were investigated. Platelets was flown through the microchannel network loop for 10 min and collected. Platelet activation was quantified by measuring P-selectin expression through FITC-anti-P-selecting and a flow cytometer. The results show that higher flow rate and abrupt changes in vessel diameter leads to an activation in platelets. The abrupt changes in vessel diameter causes vortices in flow, higher shear rate and wall shear stress. This results provide insight on platelet activation and thrombus formation in microvessel such as deep vein thrombosis.

Mathematics and Science.Engineering.18

MohamedAfify, MohamadKeblawi

University of Central Oklahoma

Smart Semi-Truck Health Monitoring & Safety System

It's estimated that there are around 500,000 fatal accidents every year in the US. Most of these accidents are due to the lack of the sefety system that is built in the trucks. Also the driver health is important as he travels for many hours and any health issue can cause a fatal death. We are are desiging a system to enhance the saftey system in the truck and a health monitoring system to check the driver health periodically and send a report if there is any danger will affect the driver.we are implementing a blind spot system and LIDAR system to detect the obstacles and alert the driver. We also are installing a system that can detect the sudden braking of the vehicle in front of the truck and warn the driver a few seconds before the accident. We are designing a medical monitoring system inside the truck to give readings of the driver health conditions to prevent accidents as heart attacks or the driver falling in sleep.

Mathematics and Science.Engineering.19

JubyVarughese

University of Central Oklahoma

Mechanical Characterization and In-silico Flow Analysis of a Flow Diverter

Flow diverters have become an efficient and promising endovascular strategy for treatment of aneurysm. However mismatch in flow diverters’ mechanical properties with aneurysm morphologies can cause restenosis, late thrombosis, rupture of aneurysm and other vascular complications. The objective of this research is to develop functional relationship among mechanical properties of flow diverters, aneurysm morphologies and fluid dynamic parameters using silicon model. A transparent PDMS carotid artery model of 5.0-5.92 mm in diameter with varying sizes aneurysm (10 mm – 25 mm) was developed using lost sucrose casting method. Flow diverters were fabricated from metallic and polymer wire. The three main mechanical tests of flow diverter were three-point bend test using the expansion and compression testing machine with specially constructed metal holder. The radial and longitudinal tensile test using the Universal Testing Machine (UTM). Fluid tests using a micro-PIV were conducted to measure the velocity and the wall shear stress of a PED. The tests were specifically chosen to replicate the performance of the PED inside a living blood vessel. The results show that flexible, higher pore density and lower pore sizes can block the fluid into the aneurysm by 80%. These results can help better understand and use flow diverters for aneurysm treatment.

Mathematics and Science.Engineering.20

TiaraTravis

University of Central Oklahoma

Modeling and Simulation of the Vessel Network Hemodynamics

The knowledge of various hemodynamic factors in blood vessels is important for understanding mechanics, states and treatment of various vascular diseases. The objective of this research is to find the change of hemodynamic parameters for various vascular network and flow conditions. Finite-element based multiphysics software COMSOL 5.2a was used to solve Navier Stokes equation with pulsating pressure conditions in bifurcation and tortuous vessel networks. The various vessel diameters were used to accommodate the changes of diameter at different ages. The arterial wall stress, shear rate, velocity profile at the junctions, vorticity and circulation rate were calculated. The results show that microcirculation and vortices can generate even in a low velocity due in tortuous vessel and junctions where multiple vessels meet. The arterial wall shear stress and shear rate follow the pattern of pulsating pressure conditions. However, in furthest and narrow vessel from the boundary the pulsating nature become weaker. This finding will help better understanding the vascular diseases.

Mathematics and Science.Engineering.21

KevinHaggard

University of Central Oklahoma

Design, Development, and Characterization of a Pipeline Embolization Device

Pipeline embolization devices (PED’s) are used to restrict blood flow to an aneurysm, thus receding the aneurysm until it has disappeared. This research demonstrates the design, development, and characterization of a biodegradable, and biocompatible pipeline embolization device for use in the carotid artery. Experimentation was done with polylactic acid, and a photopolymer to determine a suitable construction material for the PED. To confirm polymers chosen for the device are biocompatible and biodegradable, the materials are tested with multiple cellular experiments for compatibility and tested chemically for the degradation rate. Degradation rates were tested for both materials by soaking them in a phosphate buffer solution over 2,4, and 6 weeks periods and low degradation rat was observed. Designs of the PED models were built with SOLIDWORKS™ and fabricated using rapid prototyping. To find the optimal PED design, COMSOL Multiphysics® was used to simulate physiologically realistic pulsating pressure and velocity. The effectiveness was determined by the flow profiles, velocities, and shear stresses inside of an aneurysm. Mechanical testing on the PED included three-point bend test, radial test, tensile test, and ex vivo physical simulations, which were carried out by constructing an artificial artery composed of polydimethylsiloxane (PDMS). The results show that designed PED can effectively reduce fluid flow in the PDMS aneurysmal sac.

Mathematics and Science.Engineering.22

BlazeHeckert

Oklahoma State University

POSS-based Fiber Carbon-Fiber Surface Treatment for Enhanced Durability of Composites

In the proposed study, we synthesize a clickable polyhedral oligomeric silsesquioxane (POSS) carbon fiber coating to enhance the fiber-matrix interfacial properties using the highly selective "thiol-ene click" chemistry. The unique hybrid structure of POSS molecules creates a spring-like effect when strongly bound to a surface, resulting in a smooth load transfer across the interphase region, making it uniquely suited for use as a fiber surface treatment to develop damage-tolerant composite laminates. This is the first study to date that reports on the use of "thiol-ene click" chemistry to create a controlled POSS coating to enhance the interfacial properties between the fiber and matrix. Thiol-ene chemistry is the reaction between a thiol (-SH) group and alkene group, creating a bond between the two materials. PAN-based carbon fibers undergo a series of chemical modification resulting in thiolated-carbon fibers. Octavinyl-POSS is selectively "clicked" to the carbon fiber surface, creating a strongly bound uniform POSS coating. These POSS-coated carbon fibers can now be used as a prepreg for the manufacturing of composites for aerospace applications requiring enhanced composite strength and durability. The fiber-matrix adhesion is characterized using fragmentation tests to determine the interfacial shear strength. Meanwhile, the surface treatment chemistry is characterized using FTIR and XPS techniques.

Mathematics and Science.Engineering.23

LibinK. Babu

Oklahoma State University

Combined Experimental and FEA Based Investigation of Near Fiber Effect of UV Exposure in Carbon Fiber Reinforced Composites.

Characterization of the interphase region in carbon fiber reinforced polymer (CFRP) is challenging because of the length scale involved and the lack of analytical solutions that account for the fiber constraint effect. An integrated approach involving Atomic Force Microscope (AFM)-based indentation and Finite Element (FE) modeling is use to determine the extent fiber constraint effect on the properties determined in the interphase region. A gradient was observed in the elastic modulus of the interphase evaluated along a radial line from the fiber, based on which the width of interphase is determined to be 250 nm The 3D FE simulations indicate that fiber constraint impacts interphase modulus only within 40 nm of radial distance from the fiber while using AFM tip. Nonetheless, the apparent increase in interphase modulus is significantly less as compared to the overall gradient in the modulus value of the region, as determined by AFM indentation. Hence, these results confirm that the behavior of interphase is distinct compared to the bulk material. Similar results very observed for viscoelastic response of the interphase region. This approach is further utilized to evaluate the impact of Ultra-Violet (UV) irradiation on the modulus value of the interphase region as a function of exposed time and radial distance from the fiber. This study demonstrates that the response of epoxy t

Mathematics and Science.Engineering.24

MohammadHossan

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Computer simulation of laser parameters in microfabrication

Laser micromachining technology offers a promising alternative fabrication method for mass production of microfluidic channels. In this study, we performed a systematic investigation to understand the effect of various laser parameters and thermophysical properties of microfluidic substrate material (Poly(methyl methacrylate) (PMMA)) in laser micromachining. A three dimensional transient energy equation was solved using finite element method where laser induction was represented as a moving heat source with Gaussian profile. The convergence and grid independence studies were performed for the developed model. The simulation results show that the profile of the channel and cut depth are the complex function of laser parameters such as laser beam radius, laser power and moving speed as well as thermo-physical properties of the substrate such thermal conductivity, density and specific heat. For a specific laser beam radius which depends on the distance between laser tip and the target substrate, the laser power and cut depth has linear relation. Larger beam radius create wider profile with lower cut depth. However the relation between the laser beam radiuses with cut depth are not linear. The higher convective heat transfer coefficient creates lower cut depth and smoother surface in the channel. The effect of specific heat does not have significant effect on the laser machining. This study will help in selecting optimum parameters for mass fabrication of microchannels.

Mathematics and Science.Engineering.25

Prashanth ReddyKonari

University of Central Oklahoma

Laser micromachining of microchannels on various microfluidic substrates

Recent years, laser micromachinig has become a promising technology for mass production of microfluidic channels in various polymeric substrates. However excessive roughness of channel surface, lack of control of process parameters and nonuniformity of channel geometry are the ongoing challenges. In this research, we studied the effect of laser system parameters on the channel characteristics. A commercial MUSE laser system was used for machining of three widely used microfluidic substrate to create microfluidic channels. Muse Full Spectrum laser system consists of a 45W laser tube with three degree of freedom (lateral, longitudinal and vertical). Three laser system parameters - speed, power, focal distance and number of passes are varied to fabricate straight microchannel on glass, PDMS and PMMA. The results show that higher speed produces lower depth while higher laser power produces deeper channel regardless of the substrate materials. However for same speed and power, PDMS channel had the roughest surface and PMMA had smoother surface. On the other hand, number of passes produces uniform and wider channel on the PMMA. Out of focus laser cut produces wider but shallower channel. In higher power and slower speed, glass breaks. The results also show that slight heat treatment can reduce surface roughness. This comprehensive experimental investigation can provide guidance for the substrate material based mass production of microchannels.