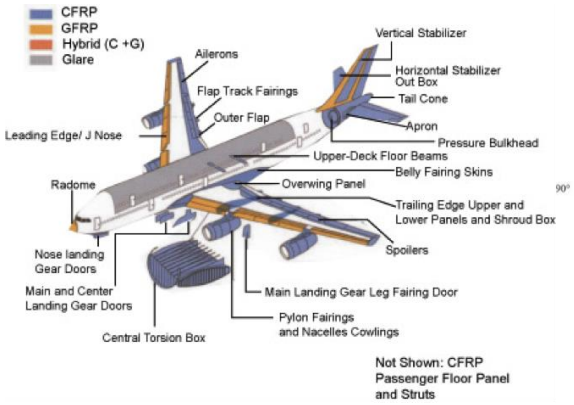
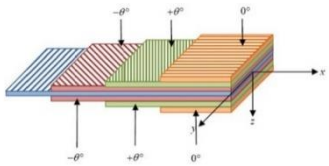
Computational Mechanics and Materials Research

Computational modeling of damage and failure in composite materials

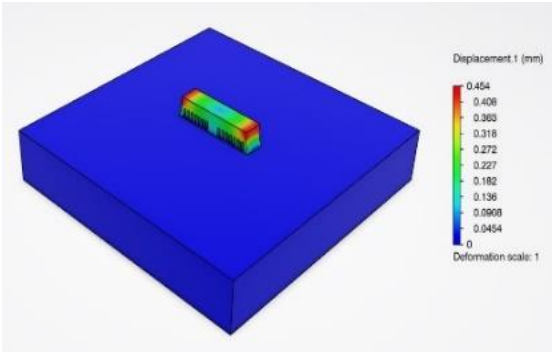
Higher strength at lower weights and close control over mechanical properties have given an edge to composite materials over metals in applications such as spacecrafts, automotive, aerospace and military vehicles. To reduce the time span for design and safe systems, there is a need for accurate and realistic computational failure analysis.





Additive Manufacturing/ Virtual printing

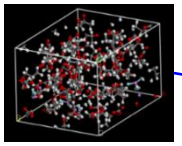
Additive manufacturing (3D printing) enables fabrication of complex geometries and provides many advantages compared to the traditional manufacturing methods is a fabrication technique of building an object in a layer-by-layer fashion using 3D cad data. Virtual printing based on thermal mechanical analysis would be an effective tool to investigate the impact of the AM process parameters on microstructure, residual stress, distortions and other post-processing effects



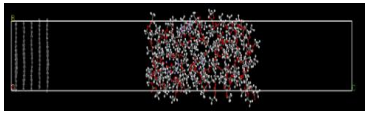
Simulation of Laser Power-Bed Fusion Additive Manufacturing Process

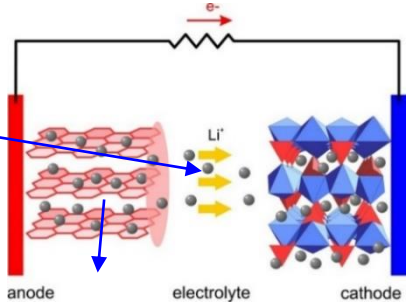
Molecular dynamics study of Lithium ion battery for enhanced performance

Nanoscale modeling and simulations help to understand fundamental electrochemical properties and the interfacial phenomena of electrolytes including interfacial energies, wettability, and interactions of electrolytes with anode/separator.



PC electrolyte in amorphous cell.

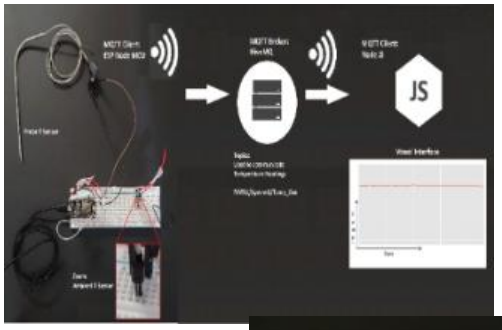




Internet of Things (IoT)-Based Sensing systems

Internet of Things (IoT)-based sensing system

The Internet of Things (IoT) uses smart devices and internet to provide innovative solutions to the challenges and issues in various applications. Park's research group developed an *IoT-based temperature monitoring system* for safe controls of temperature-sensitive food. In this system, a microcontroller is employed to collect temperature data from a temperature probe and a temperature sensor. The MQTT network messaging protocol is utilized to transmit the device data. *The smartphone-based biosensing system* developed for point-of-care testing applications can allow for rapid, convenient diagnostic testing of pathogens that contaminate foods and cause foodborne illnesses.

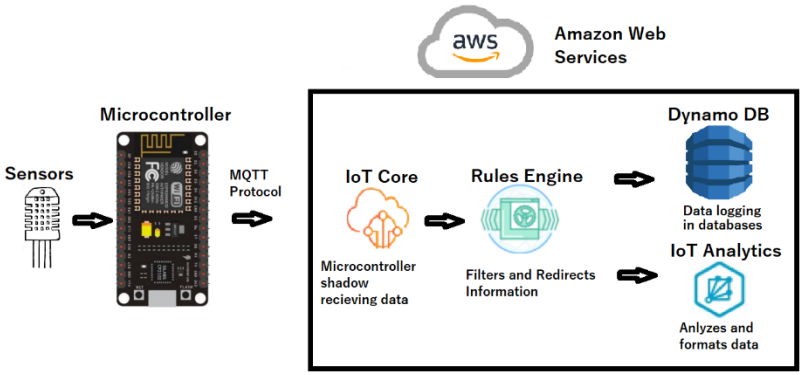


IoT-Based Temperature Monitoring System

Smartphone-based biosensing system

Cloud-based cold chain management

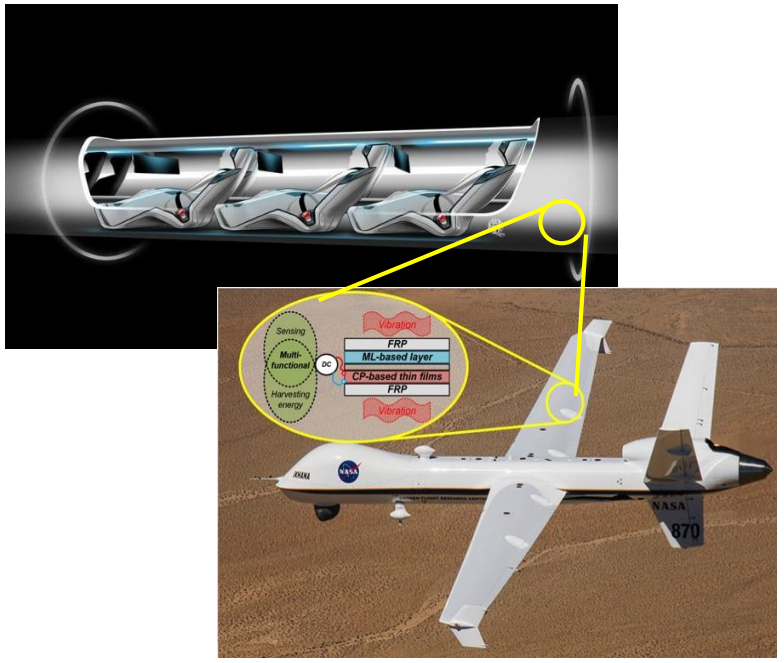
The current research will be extended to a tracking system for food or vaccine traceability with a GPS module and various sensors which communicate through a cellular gateway. To improve the traceability, IoT technology is promising for interconnecting products, shipment journeys, order information, and environmental control. IoT technology also enables the virtualization of supply chains to monitor, control, and optimize business processes in real-time. With the adoption of cloud computing, IoT-based traceability can be established to provide the functions of shipment tracking, shipment planning, transport planning, and transport tracking for perishable food or temperature critical vaccine.



Damage Diagnosis and Fatigue Life Research

Computational modeling to predict the residual strength and remaining fatigue life of composite material

Higher strength at lower weights and close control over mechanical properties have given an edge to composite materials over metals in applications such as Hyperloop, spacecrafts, automotive, aerospace and military vehicles. To reduce the time span for design and safe systems, there is a need for accurate and realistic computational model to predict the residual strength and remaining fatigue life.



Guided wave-based damage diagnosis

Fatigue crack and damage diagnosis (FDD) is of great significance for ensuring safe operation, prolonging service time and reducing maintenance cost in aircrafts and many other safety-critical systems. As a promising method, the guided wave (GW)-based structural health monitoring method has been widely investigated for FDD.