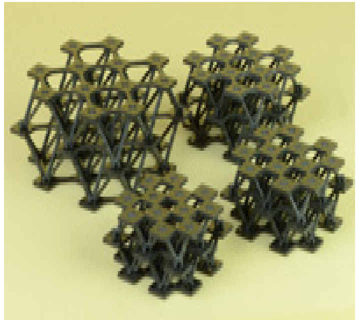

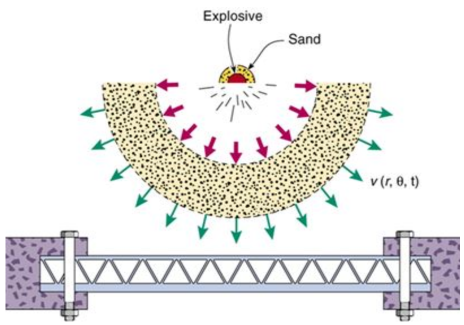

Our research group brings a fundamental materials perspective to the design and development of new high performance materials. Our group focuses on fundamental aspects of materials synthesis and processing, and the unraveling of linkages between the processes thermal, chemical and mechanical environment, the materials evolving 3D structure and its eventual performance. This approach to materials design and manufacturing therefore combines structure property relationships (to identify the optimal 3D materials states needed for particular application) with predictive process modeling, non-invasive in-situ sensing and model predictive control to make materials whose internal microstructure states are optimized. It has resulted in the development of numerous methods for making composites, cellular materials, thermal and environmental barrier coatings, and thin film multilayers that exhibit giant magneto resistance. The group has developed several novel cellular materials including a new class of cellular composites with record high specific strengths. It has also explored their application as novel multifunctional materials to enable load supporting structures to perform other functionalities such as impact protection, power storage, shape morphing and thermal management. The group's research in thermal and environmental barrier coating systems has led to improvements in the vapor phase and thermal spray processes used for the deposition of these multilayered systems, and has identified new microstructures that extend their maximum operating temperature and degree of protection.

Wadley Research Group

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"Using fundamental chemical physics principles to guide the design and development of future engineering materials and the processes to make them."

UNIVERSITY of VIRGINIA ENGINEERING

High Temperature Coatings

Efforts to increase fuel efficiency and reduce CO_2 emissions are driving increases in the temperature at which gas turbine engines operate. Our group is exploring the mechanisms by which current coatings function and eventually fail as the operating temperature rises. It is developing and exploiting state-of-the-art deposition techniques such as electron beam directed vapor and coaxial plasma deposition and plasma spray processes to create coating that provide much better protection.

Micro-cellular Materials

Nature makes pervasive use cellular materials for our bones, tree trunks, insect exoskeletons, etc. Our group is developing synthetic, topologically optimized cellular materials from high performance materials such as carbon, silicon carbide and aluminum oxide fibers using state of the art polymers and light metallic alloys to interconnect them. These materials/structures have very high specific compressive strengths and offer many opportunities to make lighter structures for automobiles, planes, ships and space vehicles.

High Intensity Impulsive Load Mitigation

The sudden localized application of a stress to a structure by explosively created shock fronts sets into motion a complex sequence of processes active across multiple length and time scales. We are investigating these phenomena and using our emerging fundamental insights to motivate the development of materials that provide much better protection. Examples include impact energy absorbing materials with cellular structures that compress when impulsively loaded. These materials reduce impulse transfer for shocks propagated in water (and to lesser extent air). When configured as the cores of sandwich structures, dynamic deflections can be reduced greatly for all types of shock loading.

Ballistic Impact Protection

The impact of a projectile with a material suddenly creates very large stresses in both the material and the projectile. These stresses then activate mechanisms of deformation and fracture in metals and ceramics, and various molecular sliding and chain scission processes in polymers. These are rate dependent and therefore the material and projectile responses are a function of the impact velocity. Our group brings this mechanistic perspective to the design of novel material systems and multi component cellular topologies that impede penetration in light weight configurations.

Thermal Management

Cellular materials are widely used for thermal management. These structures can support large bending stress while enabling large thermal fluxes to be dissipated to a cooling flow. Our groups investigates multifunctional applications of cellular structures configured as heat plates for the leading edges of hypersonic vehicles and for controlling jet engine exhaust plume heating.

RECENT RESEARCH DEVELOPMENTS

- Wadley's research group has installed a state of the art thermal spray deposition system for robotically controlled coating of ceramic matrix composites with multilayer thermal and environmental barrier coatings.
- A recently published paper in IJIE has discovered the fundamental mechanisms by which novel aluminum alloy sandwich structures interact with high velocity (explosively accelerated) sand particles that control the dynamic response.

RECENT GRANTS

- DOD/Army – A Micro-cellular Solids Approach to Thermo-Structural Materials with Controlled Architectures
- ONR – Composite Solutions to the Thermal Buckling of Plates Subjected to Localized Heating
- DARPA – A Numerical Simulation Design Approach to Soldier Protection Systems Development

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