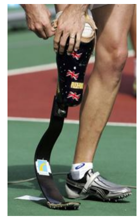
    

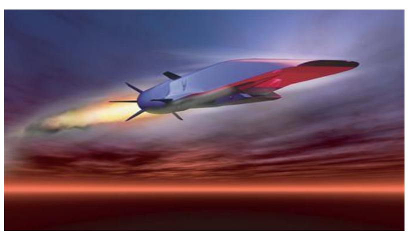
Ceramic Matrix Composites

Research in ceramics you won't find at home

Marlana Goldsmith

The images featured above have one key thing in common: they all have parts made of composites. A composite is created by combining two or more different materials to produce a material that is ideally better than the individual components in some way (for example: higher strength, lighter weight). They can be found in everyday objects such as bicycles, boats, bridges, cars, and even commercial airplanes such as Boeing's new passenger jet, the 787 Dreamliner.

Less commonly used in everyday applications are ceramic matrix composites (CMCs). These composites are special types of materials that, despite their fragile-sounding name, are very strong and able to withstand extreme temperatures, making them ideal for vehicles that reach temperatures of 3000 degrees Fahrenheit (almost 1000 degrees hotter than lava) while traveling up to 6 times the speed of sound (768 miles per hour). Current military aerospace applications for CMCs include the X-51 Waverider and the F-35 Lightning II (pictured below).



X-51 Waverider

F-35 Lightning II

Typically, a composite's material properties are determined through an understanding of the physics that controls their behavior, computer modeling, and experimental tests. However, ceramic matrix composites are very expensive (e.g. $10,000 for a 1 ft. x 1 ft. sample). This limits the amount of experimental tests that can be done and increases the reliance on computer models.

Developing computer models that aid in our understanding of how ceramic matrix composites will behave is part of the research being done at University of Florida and NASA. The CMC under investigation here is first woven with bundles of thin fibers, like a cloth, as illustrated in Fig.1. Then, further chemical processes produce the final product. During the weaving and chemical processes, defects (imperfections such as holes) in the material are created. These defects may cause the material to fail or break earlier than expected. Understanding how to appropriately model these defects will increase our understanding of the impact the defects will have on material performance while reducing the amount of testing required to ensure safety during their use. Most importantly, developing these models will decrease the amount of time and cost required to take a CMC material from an idea, to an application.

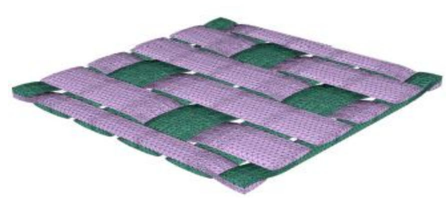


Figure 1. Model of woven fiber bundles

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