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An Overview of Carbon-Carbon Composite Materials and Their Applications

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This article is particularly relevant to my group's project due to its sections on Carbon-Carbon composite testing. The article details popular ways to measure mechanical, thermal, fatigue, and microscopic properties. Non-destructive testing is also discussed in the article. Infrared thermographic measurements are a good way to measure small defects and coating thickness. Non-destructive testing would be a great way to allow my group to perform as many tests as possible while still being mindful of manufacturing time constraints. This article is relevant to my group's project also because of its in-depth description of what Carbon-Carbon composites are and why they are so valuable to the field of aerospace engineering. This insight will help us relate to others (professors, future employers, other students) what our project is and the importance of it in the broader field.

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Page Two – Summary of Article

This article mainly focuses on two topics: what are Carbon-Carbon composites and how does one test them? Carbon-Carbon composites are made of carbon fibers in a carbon matrix. These composites are known to be light weight and maintain their structural resilience at high temperatures. The aerospace industry has particular interest in C/C composites, particularly for heat shields and airplane braking systems. The article covers testing by describing destructive and nondestructive methods. Testing mechanical properties of C/C composites typically includes opening, in-plane shear, and out-of-plane shear. To test opening, the material is split apart, and the force applied is recorded. In-plane and out-of-plane shear tests are preformed to determine how a C/C composite will behave under shear from different orientations. These forms of mechanical testing are destructive. Nondestructive testing for C/C composites usually includes methods that detect small defects, coating thickness, and corrosion.

The article also discusses how C/C composites maintain their structural integrity. C/C composites can be repaired externally through the addition of a healing agent and internally through reversible molecular bonds. Since C/C composites are frequently used in high temperature environments, a protective coating is usually applied to them to prevent oxidation. The article discusses coatings that increase the longevity of C/C composites, specifically with Zirconium diboride which provides protection to the composite in high temperature re-entry situations. Other coatings discussed include Silicon dioxide, Boron carbide, and Silicon carbide.

Machining of Carbon-Carbon composites is another topic discussed in detail by the article. During machining, C/C composites are prone to delamination. This can make the strength of the composite decrease. To avoid these issues, the article discusses laser cutting and electric discharge machining. These two machining methods are typically used in making stronger materials that have difficulty being cut with other methods. Laser cutting in particular, as described by the article, is used to cut patterns in Carbon-Carbon composites. Abrasive flow machining uses thick fluids to shave off parts of C/C composites and push away the debris. This form of machining is described by the article as very effective for C/C composites.

Another area the article discusses is reinforcing Carbon-Carbon composites. Carbon fibers are chemically inert, so they have problems binding with Carbon matrices. Carbon nanotubes are often used to help reinforce the Carbon matrix. One type of Carbon nanotube the article mentions is Graphene oxide. Graphene oxide has many polar groups on it, so it can easily interact with the carbon fibers and the matrix.