Manufacturing and Mechanical Characterization of a Carbon Infused Metal Hybrids

Current advancements in manufacturing have made it possible for large amounts (>10 wt%) of carbon (C) to be incorporated during a reaction process in molten aluminum (Al), copper (Cu), silver (Ag), and other elements. These materials, developed by Third Millennium Materials, LLC, are called “covetics”. The process of conversion to covetics consists of heating the metal to a temperature above its melting point, adding C in various forms and applying a direct current to the melt while stirring. This process is a relatively simple process that produces a material with many unique and improved properties over the base metal from which it is generated. After the conversion process, the C is highly stable and remains dispersed in the material after remelting and resolidification. The C bonds to the metal matrix and has an effect on several of the properties of the material.

In this project we will concentrate on the manufacturing and characterization of metal covetics with varying amount of C. The mechanical properties of covetics will be measured by tensile test (Young’s modulus, 0.2% yield strength, ultimate tensile strength, and elongation), Charpy impact test (energy absorption), nanoindentation (elastic modulus and hardness) and Vickers and Rockwell methods (hardness). Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD) will used to analyze the structure of these materials. Carbon content of covetic materials will be examined by Energy Dispersive Spectroscopy (EDS).

The “covetics” materials will be tested for suitability in real life. Mechanical failures involve a complex interaction of load, time, and environment. Loads may be monotonic, steady, variable, uniaxial or multiaxial. The loading duration may range from seconds to years. Environment can affect in two ways such as temperature and corrosion. Temperatures can vary from cryogenic to over a thousand degrees Celsius. It may be isothermal or variable. Corrosive environments can range from severe attack with automobile engine exhaust and salt water exposure, to essentially no attack, in vacuum or inert gas. We plan to determine fatigue and fracture properties of these materials under different environment conditions before they can be safely used in real life. Concisely, we will explore the effect of the presence of carbon on the properties in covetics.

The REU student will participate in the manufacturing and characterization of covetics. In the process they will learn a new technique for manufacturing of metal hybrids and gain knowledge of material characterization.

REFERENCES