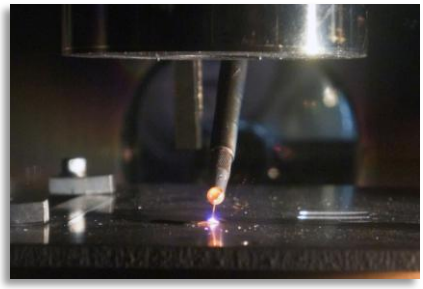
Functioning Graded, Load Optimized Structure via Additive Manufacturing Techniques

Craig Brice
Research Materials Engineer

Today's structures are designed geometrically to optimize load-carrying capacity and made as uniform monolithic materials.

At NASA Langley Research Center, Craig Brice is investigating novel methods of creating new alloys using an additive manufacturing process. Through an award from Langley's Center Innovation Fund Program, Brice is looking at introducing gas into the process.

"What I would like to do by using the method where I introduce gas into the additive manufacturing process is I can locally change the chemistry and the alloy in concentration, such that I can modify the properties in very specific locations within a given part.



Electron Beam Free Form Fabrication (EBF^3) Process

"By using additive manufacturing, I can put material where I want it. I'm additively creating structure incrementally in a uniform manner."

Brice introduces a gas through a hollow wire into the process at specific times wherever he wants a reaction to occur, such that he achieves new, refined compositions in various locations.

"The approach gives me a lot of flexibility in terms of being able to modify the composition of the alloy within a given part and create a very overall efficient structure from a load-carrying capability."

According to Brice, all of the alloys will react well with specific gases to create very unique materials and structures. However, right now, he is only using stainless steel needle stock because it is readily available from vendors.

The goal will be to produce a deposit that's 100% dense. One side of it will have one composition, and the other side will have a slightly modified composition.

"If I can do that, then I can demonstrate that I can control the process and put local chemical variations where I want it, and then you'll have something that's fairly unique."

Test using stainless needle stock and EBF^3

Although his field is metals, Brice thinks the method could possibly be used for composites as well, or a combination of materials. Another idea is adding particulates.

"Instead of just using gas, you could entrain some type of particulate in that gas as well, such as a nanocomposite material, such that you could feed not just gas that will react but a particulate material that will be incorporated into and create a composite structure."

He believes the method would have many applications in standard welding approaches, but would like to see it used for aerospace structures one day.

"I hope to take it to where now composition can be used to optimize aerospace structures, as opposed to just one material, by using geometry to create that structure in an efficient manner. Now I can modify the chemistry wherever I need to have desired properties that I'm after."