Beryllium hits the target for optical and guidance systems

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Metallic beryllium and AlBeMet materials are used in the optical targeting systems of military fighter jets.

Beryllium is not a new material in the aerospace and military sectors. It has long been used in support of intercontinental ballistic missile (ICBM) programs begun over a half century ago, before branching into other applications such as satellites and airborne systems. And more recently, the metal is still branching into new areas, a notable one being in UAVs.

“A lot of new UAVs are starting to use more and more beryllium—a lot of the airborne tactical reconnaissance,” said Larry Ryczek, Vice President of Sales and Marketing for Beryllium Products at Ohio-based Brush Wellman Inc., noting that the main areas for beryllium in the aerospace sector are in airborne optical systems and in the seeker systems on some of the new missiles such as in the Ground Based Interceptor.

“There’s a lot of new technology in the hyperspectral range too,” Ryczek said. “One application that we’re doing a lot of work on is landmine detection. And we have infrared targeting systems, which is where our initial applications were.”

Beryllium is one-third lighter than aluminum yet six times the specific stiffness (modulus divided by density) of steel. Most metals, such as aluminum, have about a 1:1 ratio of modulus to density, but beryllium’s ratio is about 6.5:1, said Ryczek. “The reason that’s important for optical structures, for example, is it allows you to design very lightweight, stiff systems that can…scan, turn, and sight the optic without it vibrating and resulting in

bad picture quality."

For that reason, almost all high-end airborne optical systems are made using beryllium materials, according to Ryczek. For example, the new Joint Strike Fighter will use beryllium in its electric optical system, he said, and the upgrades to the F-16 and F-18 targeting systems included beryllium components.

Among Brush Wellman's product offerings is a beryllium microalloy, which is 99% beryllium metal with less than 1% alloy additions, and its AlBeMet (aluminum beryllium metal) metal-matrix composite, which is used in the same type of applications but consists of only 62% beryllium by weight, 38% aluminum. "The reason for that is because it's more fabricable and lower cost, [a solution] for some of the lower-end systems that still need performance," explained Ryczek.

Beryllium also has a relatively low coefficient of thermal expansion—lower than, say, aluminum, but not as low as some composites—which allows its use across a broad temperature range, in applications such as heat sinks. But what it offers in terms of weight reduction, either by itself or in combination with aluminum, is often the deciding factor in its use.

"If you're substituting an aluminum-beryllium heat sink for an aluminum heat sink, you can get a 25% weight savings just by swapping out the same design," Ryczek said, adding that the weight savings could be as high as 50% if the component is designed up front for beryllium. "The earlier we can get in, generally the larger the weight savings because you can optimize the design at the beginning," he said. "And the other advantage with the aluminum-beryllium material for those kinds of applications is that because it machines and fabricates very much like aluminum, it's virtually a direct swap."

Early design optimization helps with another very important aspect: cost. "The earlier we can work with customers to give them good design trades, the better off we are in terms of selling our price/performance [equation] and the better off they are in maximizing the value for the material," he said.

Decreasing the price portion of that equation explains why Brush Wellman has adopted the use of near-net shaping and electron-beam (e-beam) welding. The company's materials are powders, not cast products, and the powder is very expensive, noted Ryczek. "So if we can reduce the amount of powder used in every system that's produced, we can reduce cost."

To achieve that goal, engineers designed HIP (hot isostatic press) cans that are shaped as near to the shape of the finished machine component as possible, thus removing "a number of pounds of material" from the process, explained Ryczek.

For its AlBeMet product, e-beam welding—a high-temperature weld beam that makes a very thin weld joint—also does a good job of reducing the amount of material needed per unit. "When you e-beam weld, you reform the metal-matrix composite at the weld joint, so effectively it's like you never had separate parts when you're done welding," he said.

Brush Wellman also has recently assembled a group called SPADE (Special Products and Application Development Engineering) whose purpose is to make it easier for customers to use beryllium.

"As new applications have come up, some people don't understand how to work with our material; they have perceptions that it's going to be hazardous or it's super expensive or you can't get it anywhere. We can work with them on their designs…to get the maximum weight savings, and work with fabricators who understand how to process beryllium material safely. We can then deliver these finished components to end users and…help assemble them into their optical systems," Ryczek said, pointing out that beryllium is safe

to handle in finished form, such as parts.

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