# First powder injection molding process for pure niobium

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Penn State researchers have developed the first powder injection molding process for pure niobium, a biocompatible material similar to platinum and titanium but cheaper.
The researchers, who are based in the University's Center for Innovative Sintered Products, say the new process could open the door to injection-molded niobium parts ranging from rocket nozzles, to wires, to human bone replacements, to orthodontic braces.

Gaurav Aggarwal, doctoral candidate in engineering science and mechanics, will present the team's work in a paper, Development of Niobium Powder Injection Molding, at the International Symposium on Tantalum and Niobium in Pattaya, Thailand, Oct. 17. His co-authors are Seong J. Park, research associate in engineering science and mechanics, and Dr. Ivi Smid, associate professor of engineering science and mechanics, who is Aggarwal's thesis adviser.

Aggarwal notes that other researchers have developed techniques for processing niobium via powder metallurgy and some have applied powder injection molding to niobium-based alloys and superalloys. However, the Penn State team is the first to explore processing pure niobium via powder injection molding. They have developed a method to calculate the optimal proportions of niobium powder to binder in feedstocks as well as the appropriate temperature and duration for sintering.

The team's method for calculating the optimal metal powder/binder proportions also can be applied to other materials which, like niobium, have irregularly-shaped particles.

Aggarwal points out that pure niobium products are currently formed from powders and, therefore, there is no powder cost penalty as in ferrous materials, for example. Although it is biocompatible and benign in use, niobium is difficult to control at the high temperatures needed to process it because of its high reactivity.

In the Penn State approach, powdered niobium is mixed with the appropriate binder in proportions roughly 92 percent niobium by weight and 8 percent binder by weight. The feedstock is then processed in a standard injection-molding machine.

The resulting part is placed in a solvent that dissolves out the binder and then is heated to drive off the solvent and any remaining binder. The part is then processed in a sintering furnace.

The researchers have validated their approach experimentally. The injection temperature and pressures were determined for optimal filling time based on simulation.

Source: Penn State

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