Manipulating Materials for Orthopedic Implants

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The use of today’s advanced materials can be advantageous for orthopedic implants and instruments as they can offer a variety of benefits. However, they can also create challenges for developers concerned with getting the exact tolerances needed. Machining these materials to achieve the desired results is a service best outsourced to a solutions partner who is an expert with a given material.

Bone staple

Shape memory alloys offer unique material properties to the orthopedic industry. The ability to maneuver through tight, torturous anatomical pathways is a key differentiating factor for shape memory based NiTi alloys. While these materials offer new possibilities that were previously unattainable using conventional materials, machining them can be a challenge. NiTi alloys are unique in that they work harden rapidly and are sensitive to thermal loads induced during manufacturing. In addition, devices produced from NiTi can be formed post-machining to yield complex device shapes. Because of these factors, it is critical for designers to find a solutions partner that is fully versed in both material and processing.

NiTi alloys are of particular benefit to the sports medicine segment of the orthopedic market. The main benefit of these alloys is the ability to accommodate up to 6% strain without permanent deformation when in the superelastic condition. While this unique attribute makes NiTi alloys an attractive option for designers, it needs to be balanced against high material and processing costs. In particular, knowledge of the material is critical for effective, close tolerance processing.

Orthopedic implant

There are several machining techniques available for effectively manipulating NiTi. All standard milling, drilling, and turning techniques are possible, but only under the correct parameters. Conventional techniques such as these need to be carefully chosen because of the high ductility and rapid work hardening of the material. Additionally, because of the heat generated at the cutting surface, appropriate cutting conditions/coolants must be employed. Care must be taken when choosing cutting coolants to avoid any fluid containing Halogen elements (Fluorine, Chorine, Bromine, and Iodine) due to their highly corrosive nature when exposed to NiTi alloys. This is especially critical in applications with small or blind features that post-process cleaning may not reach.

For some applications, conventional machining techniques may not be suitable due to the high cutting forces imparted during manufacturing. In instances such as these, electrical discharge machining (EDM) or profile grinding techniques can be employed. These processes allow complex, close tolerance geometries to be achieved under minimal to no load conditions. Orthopedic soft tissue anchors and instrumentation are examples of devices that lend themselves to this style of machining. EDM is capable of producing crisp features down to a few thousandths of an inch in thickness, which is advantageous for developers trying to achieve micro instrumentation. While this technology may be ubiquitous in the industry, it is critical to find a solutions partner that is experienced in both the machining technique and material. Several factors must be considered when using EDM with NiTi alloys—work holding, cutting conditions, and subsequent post-processing activities. These factors all play a role in choosing an EDM strategy that achieves the desired tolerances and does not degrade the material properties.

Spinal rod

The ability to consistently and reliably hold components for machining is also critical when considering advanced materials. Whether an array of components or a single component is being held, fixturing is the critical foundation for all machining activities. At Memry [1], this is accomplished through the use of precision fixturing developed and produced internally. Experienced toolmakers can develop work holding solutions for applications ranging from single station “soft” tooling all the way up to full-scale production tooling. Knowledge of the abrasive, yet ductile nature of NiTi alloys has enabled engineers and toolmakers to design and build robust fixturing to accommodate any machining technology or production volume.

Identifying a strategic solutions partner is crucial for designers looking to maximize their designs when working with advanced materials. This is especially important in today’s quick-turn environment. Developers who partner with an OEM capable of taking a product from conception through mature production have a clear advantage

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