



**PRECISION
MACHINING**
A Michelin Group Company

HOW TO UTILIZE POLYACETAL DELTRIN® IN MEDICAL DEVICE MANUFACTURING

The combination of dimensional stability, chemical resistance, and biocompatibility makes Delrin® an ideal choice for various medical applications.



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PRECISION MATTERS

MEDICAL & LIFE SCIENCES NEWSLETTER



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MEDICAL STERILIZABLE PLASTICS: WHICH OUTPERFORMS IN DIMENSIONAL STABILITY TESTS?

Which Material Offers Superior Dimensional
Stability for Medical Devices?



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MEDICAL DEVICE MANUFACTURING: PRECISION MACHINING FOR ORTHOPEDIC IMPLANTS

Medical device manufacturing has revolutionized
the healthcare industry, particularly in
orthopedic implants.





WE'RE NOT YOUR REGULAR MACHINISTS. WE CARE.

Here at AIP Precision Machining, we're not your conventional machine shop. We offer state-of-the-art technology, extensive material expertise through our skilled and caring professionals and the utmost quality while delivering quick turn-around times and cost-effective results.

Our team of highly-skilled engineers, machinists and programmers aren't just problem-solvers, they're precision-machining craftsmen—they'll believe in your project's potential as much as you do. We take engineering consultancy seriously and will give an honest recommendation that's best for the project over what's best for AIP's pockets.

We love what we do. With 40+ years of experience working with numerous different polymers and geometries, we're ready to take on any customer challenge and we take pride in discerning the most appropriate material and process solutions to meet your needs, and with our expertise machining polymers into complex geometries, we aim to exceed your expectations every time.



John MacDonald
President

MEDICAL STERILIZABLE PLASTICS: WHICH OUTPERFORMS IN DIMENSIONAL STABILITY TESTS?



In the demanding field of medical device manufacturing, sterilizable plastics are essential for ensuring safety, longevity, and precision. Materials such as PEEK, Radel® PPSU, and Ultem™ PEI offer unparalleled resistance to high-temperature sterilization, aggressive chemicals, and repeated mechanical stress. Their ability to maintain dimensional stability under repeated sterilization cycles is why they are increasingly replacing metals in reusable surgical instruments and housings.

Among these materials, PEEK stands out for its ability to endure over 1,000 steam sterilization cycles with minimal dimensional change. However, understanding how various sterilization methods affect the mechanical and structural integrity of different polymers is critical when designing components for long-term use.

Sterilization Methods and Their Effect on Plastics

Medical devices undergo sterilization using a variety of techniques, each with its own thermal and chemical demands. These processes directly influence the lifespan and dimensional stability of polymer components.

Steam Sterilization

Steam sterilization, also known as autoclaving, is the most common technique used in clinical environments. It operates at temperatures of 121°C for 30 minutes or 132–134°C for 3–4 minutes. The intense thermal load and humidity create significant stress on most polymers.

High-performance plastics like PEEK handle this process remarkably well, maintaining their shape and strength after more than 1,000 cycles. Radel PPSU retains integrity up to approximately 800 cycles, though color changes may begin earlier. In contrast, general-use polymers like polypropylene, polyamide, and polycarbonate often begin to deform or crack before reaching 100 cycles.

Certain biodegradable polymers, such as PLA, undergo crystallization near their glass transition temperature, resulting in measurable shrinkage and a shift in mechanical behavior. This limits their application in reusable devices.

Ethylene Oxide and Hydrogen Peroxide Gas

Ethylene oxide (ETO) sterilization offers a lower temperature process, often used for heat-sensitive instruments. However, it can still cause shrinkage in certain materials, particularly those sensitive to moisture or with less stable polymer chains.

Hydrogen peroxide gas plasma sterilization, typically operating at 37–44°C, exerts minimal stress on high-performance materials. Plastics like PEEK, PPSU, and PEI retain both shape and mechanical properties across numerous hydrogen peroxide cycles, making this method increasingly preferred for facilities aiming to avoid toxic ETO residues.

Gamma Radiation

Gamma radiation is used extensively for single-use medical devices due to its deep penetration and effective sterilization. However, the process generates free radicals in polymers, triggering chain scission and crosslinking. These chemical changes accumulate with repeated exposure and can lead to embrittlement or stiffening.

Materials such as PEEK, Ixef PARA, Ultem PEI, and Radel PPSU demonstrate high resistance to these effects, even after multiple exposures. Conversely, polycarbonate and acetal often experience reduced toughness and dimensional changes after repeated gamma cycles.

Performance Profiles of Top Medical Polymers

PEEK

PEEK demonstrates long-term performance under extreme conditions. After 50 steam cycles, it shows only a slight reduction in lateral dimensions and minimal mechanical degradation. Its compression force decreases by about 20% within the first 30 cycles and then stabilizes. Surprisingly, hardness increases by nearly 50% within the first 20 cycles, suggesting densification or alignment of polymer chains. Despite these internal changes, PEEK retains its critical functional properties even after 1,000 cycles.

Radel PPSU

Radel PPSU provides an exceptional combination of impact resistance, thermal stability, and visual clarity. It can withstand over 1,000 autoclave cycles without significant structural loss. While some color change occurs after 300–500 cycles, mechanical performance remains stable well beyond that point. For applications where visual appearance supports device function, such as color-coded surgical tools, Radel's resilience to discoloration is advantageous.

Ultem PEI

Ultem PEI offers superior thermal resistance, with a glass transition temperature of 217°C. This high threshold ensures dimensional predictability across a wide range of sterilization processes. After 2,000 autoclave cycles, Ultem retains its tensile strength, and glass-filled grades enhance stiffness for structural components. These properties make Ultem ideal for high-heat applications where dimensional drift cannot be tolerated.

Polysulfone (PSU)

Polysulfone holds up well through approximately 500 steam cycles. Although its elongation tends to drop with extended exposure, its modulus and

Polymer Properties

Radel PPSU

Exceptional impact resistance, thermal stability, and visual clarity. Withstands over 1,000 autoclave cycles.



Polysulfone (PSU)

Holds up well through approximately 500 steam cycles. Elongation drops with extended exposure, but modulus and strength improve.

Ultem PEI

Superior thermal resistance with a glass transition temperature of 217°C. Retains tensile strength after 2,000 autoclave cycles.



strength slightly improve due to an annealing effect. Still, the onset of crazing and stress cracking limits its long-term durability compared to PPSU and PEEK.

Long-Term Durability and Visual Stability

Sterilization-induced color shifts often precede mechanical failure. For instance, PPSU begins to yellow after a few hundred hydrogen peroxide cycles, yet its structural performance remains strong until well beyond 800 cycles. Visual changes do not necessarily indicate that a material has failed but may be unacceptable in devices where appearance affects usability or regulatory classification.

Healthcare-grade PEI shows excellent color retention, with only minor shifts even after hundreds of sterilization cycles. This visual predictability is useful in applications involving clear housings or visible instrumentation.

Material Performance Across Multiple Sterilization Methods

Few plastics can withstand multiple sterilization

methods without degradation. Polycarbonate, for example, tolerates gamma radiation well but fails quickly under steam. Meanwhile, PEEK and PPSU remain stable across both high-heat and high-radiation environments, making them ideal for facilities that use mixed sterilization protocols.

For hydrogen peroxide sterilization, PEEK retains nearly 100% of its mechanical strength after 150 cycles. PPSU follows closely, preserving approximately 92–96% of its baseline tensile strength. These high retention rates offer confidence in critical devices expected to undergo repeated reprocessing.

Factors in Material Selection for Medical Devices

Choosing the right plastic involves much more than thermal and mechanical performance. Engineers must weigh biocompatibility, assembly methods, and long-term cost against sterilization compatibility.

Biocompatibility Standards

ISO 10993 is the most widely adopted framework

for biocompatibility, taking a comprehensive, risk-based approach. It classifies devices based on contact type (surface, external communicating, implantable) and exposure time.

USP Class VI is a more limited classification, focusing on systemic toxicity, irritation, and implantation responses. While still referenced, it is less predictive of long-term biological response than ISO 10993.

Plastic Joining Techniques and Sterilization Impact

Sterilization can compromise the bonds between plastic components. Gamma radiation, in particular, can reduce adhesion or cause warping at welded joints due to internal chain scission. Therefore, assembly methods must be chosen with sterilization compatibility in mind.

Chemical bonding generally holds up well under ETO but may fail with radiation. Ultrasonic welding is often preferred for steam-sterilized components made of PEEK or PPSU, as it delivers robust joints with minimal heat impact on surrounding material.

Cost vs. Lifecycle Value

Materials like PEEK come at a higher initial cost, but their ability to survive over 1,000 cycles without failure offers compelling lifecycle economics. For critical reusable devices, the extended service life justifies the expense. In contrast, less expensive materials may suffice for instruments expected to withstand only a few hundred cycles or for single-use applications.

Conclusion

The dimensional stability of sterilizable plastics is central to the reliability and safety of reusable medical devices. Whether selecting materials for surgical instruments, sterilization trays, or diagnostic housings, engineers must consider thermal exposure, sterilization frequency, and chemical resistance.

Materials like PEEK, Radel PPSU, and Ultem PEI offer superior performance across all major sterilization methods. Their stability, strength, and long-term durability enable designers to meet increasingly strict regulatory and operational standards.

If your team is developing medical devices that demand sterilization resilience and tight tolerances, AIP Precision Machining can help identify the optimal material and machining process. Reach out to learn how we support OEMs with engineered plastic components designed for maximum longevity and compliance.

[Read the full article here:](#)





HOW TO UTILIZE POLYACETAL DELRIN® IN MEDICAL DEVICE MANUFACTURING

Material selection plays a crucial role in medical device manufacturing, where patient safety and device performance cannot be compromised. Polyacetal Delrin® stands out as a preferred engineering plastic for medical applications, offering exceptional mechanical properties and reliability.

The combination of dimensional stability, chemical resistance, and biocompatibility makes Delrin® an ideal choice for various medical applications.

This FDA-approved material excels in the production of surgical instruments, drug delivery devices, and prosthetic components. Medical device manufacturers benefit from Delrin®'s excellent machining characteristics, sterilization compatibility, and consistent performance across different manufacturing processes, from injection molding to CNC machining.

Properties of Polyacetal Delrin® for Medical Devices

Polyacetal Delrin® exhibits a comprehensive set of properties that make it exceptionally suitable for medical device applications. These characteristics ensure reliable performance across various medical implementations while maintaining strict safety standards.

Chemical resistance and biocompatibility
Delrin® demonstrates excellent resistance to organic solvents and neutral chemicals, particularly at temperatures below 70°C. The material maintains strong chemical stability against alcohols, aldehydes, esters, and

hydrocarbons while resisting discoloration. For medical applications, specific grades like Delrin® SC comply with USP Class VI and ISO 10993 standards, though biocompatibility studies indicate limited direct bone contact applications.

Mechanical strength and dimensional stability

The material's mechanical properties make it ideal for precision medical components:

Property	Value/Characteristic
Tensile Strength	10,000 psi at room temperature
Flexural Modulus	410,000 psi stiff
Elongation	10-40% at break
Temperature Range	Effective to -40°C

Delrin® maintains exceptional dimensional stability with tight tolerances of ± 0.005 , crucial for medical device precision. Its low moisture absorption makes it particularly suitable for humid environments without compromising structural integrity.

Low friction and wear resistance

The material's tribological properties are particularly valuable in medical applications:



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- Coefficient of friction against steel: 1-0.3
- Consistent performance under varying thermal conditions and loads
- Superior resistance to both adhesive and abrasive wear
- Excellent fatigue resistance under cyclic stress of 5,000 psi

These properties make Delrin® especially effective in applications requiring smooth actuation and repeated movement, such as surgical instruments and drug delivery devices. The material's inherent lubricity eliminates the need for external lubricants, maintaining cleanliness in medical environments.

Manufacturing Techniques for Delrin® Medical Components

Manufacturing Delrin® medical components requires precise control over fabrication processes to ensure optimal performance and reliability. Two primary manufacturing methods dominate the medical device industry: injection molding and CNC machining.

Injection molding process

Injection molding represents the preferred method for high-volume production of Delrin® medical components. The process enables the creation of complex geometric shapes while maintaining tight tolerances. Modern injection molding systems utilize hot-tip runners and controlled

cavity pressures to achieve optimal results. Key processing parameters include:

Parameter	Recommended Range
Melt Temperature	215°C ± 5°C
Nozzle Temperature	190°C
Packing Time	Based on wall thickness
Gate Design	Min. 50% of wall thickness

CNC machining of Delrin® parts

CNC machining offers exceptional precision for medical-grade Delrin® components, achieving tolerances up to ±0.001 inches. The material's high machinability factor (0.7 compared to steel) enables efficient processing with standard equipment. Sharp cutting tools with high clearance angles produce the best results, while air-based cooling systems help maintain dimensional stability during machining.

Design considerations for Delrin® components

Successful manufacturing of medical devices requires careful attention to design elements that optimize both production efficiency and component performance:

- Maintain uniform wall thickness
- Wall Thickness and Structural Elements
- Include appropriate fillets and ribs
- Design proper gate locations
- Avoid sharp internal corners (min. 1mm radius)

Temperature management plays a crucial role in both manufacturing processes. Parts should be ejected hot during injection molding and allowed to cool naturally to prevent warping. For CNC machining, maintaining temperatures below 121°C ensures optimal material properties and prevents degradation during processing.

The manufacturing process selection depends on



factors including production volume, component complexity, and required tolerances. While injection molding suits high-volume production of complex parts, CNC machining excels in producing precise, custom components for specialized medical applications.

Applications of Delrin® in Medical Devices

The versatility of polyacetal Delrin® has established it as a cornerstone material in modern medical device manufacturing. Its exceptional properties make it particularly valuable across various medical applications, from precision instruments to life-changing prosthetics.

Drug delivery systems

Delrin®'s dimensional stability and wear resistance make it ideal for drug delivery devices. The material excels in insulin delivery pens, where precise dosing mechanisms rely on its superior mechanical properties. Modern inhalers utilize Delrin® components for dose-counting mechanisms, leveraging its low friction properties for smooth actuation. Patch pumps and auto-injector devices benefit from Delrin®'s ability to maintain tight tolerances and resist deformation over multiple use cycles.

Surgical instruments and equipment

Medical professionals rely on Delrin®-based surgical instruments for their durability and precision. The material's properties are particularly valuable in:

Application	Key Benefit
Tubing Clamps	High fatigue resistance
Diagnostic Equipment	Chemical resistance
Valve Components	Low moisture absorption
Medical Pumps	Dimensional stability

Prosthetics and orthopedic devices

Delrin® has revolutionized prosthetic development, particularly in joint applications. The LIMBS Knee system demonstrates Delrin®'s capabilities in prosthetic applications, utilizing its high stiffness and wear resistance over millions of flexing cycles. Clinical studies have shown remarkable success in hip prostheses, where Delrin® components exhibit:

- Ten times higher creep resistance compared to ultra-high molecular weight polyethylene
- Exceptional hardness for resisting abrasive action
- Minimal wear on articulating components
- Benign tissue response similar to polyethylene implants

The material's performance in orthopedic applications is particularly noteworthy, with over 7,000 successful surgical procedures documented using Delrin®-based prostheses. Its combination of strength, durability, and biocompatibility continues to drive innovation in medical device design, enabling more compact and efficient solutions for patient care.

Regulatory Compliance and Quality Control

Ensuring compliance with regulatory standards is paramount in medical device manufacturing using polyacetal Delrin®. Manufacturers must navigate complex requirements while maintaining stringent quality control measures throughout the production process.

FDA regulations for Delrin® medical devices

The Food and Drug Administration (FDA) maintains strict oversight of medical-grade Delrin® components through a comprehensive review process. Manufacturers must demonstrate compliance with FDA-recognized voluntary

consensus standards, particularly ASTM F1855-00, which specifically addresses polyoxymethylene for medical applications.

The regulatory framework requires:

- Premarket submission validation
- Conformity to internationally recognized standards
- Documentation of material composition and processing methods
- Verification of biocompatibility for specific applications

Sterilization methods for Delrin® components

Medical device manufacturers can employ various sterilization techniques for Delrin® components, each with specific parameters and considerations:

Sterilization Method	Temperature	Duration	Maximum Cycles
Steam Autoclave	134°C	10 minutes	800 cycles
Ethylene Oxide	55°C	45-80 minutes	Unlimited
Gamma Radiation	Ambient	Process-specific	Limited
Plasma (H ₂ O ₂)	45°C	45-80 minutes	1,000+ cycles
PCTFE	High	Low	No

Quality assurance protocols in manufacturing

Quality control measures for medical-grade Delrin® components incorporate ISO13485 certification requirements and comprehensive testing protocols.

Manufacturing facilities must maintain:

- Process Validation
- Initial inspection of molded parts
- Dimensional accuracy within 0.001" tolerance
- Material property verification
- Surface finish evaluation
- Documentation Requirements
- Complete Design for Manufacturability (DFM) records
- Material certification documentation
- Sterilization validation reports
- Batch testing results

Manufacturers must perform regular quality audits and maintain detailed records of all testing procedures. The emphasis on precision and quality control ensures that final products meet or exceed the required specifications for medical applications while maintaining compliance with regulatory standards.



CASE STUDY

SITUATION

The client, a leading manufacturer of neuro intervention devices, required a solution to improve the performance and durability of their neurovascular stents. These devices are critical in treating brain aneurysms and must withstand complex, high-stress environments within the human body.



CHALLENGE

The neurovascular stents were experiencing performance issues due to suboptimal material properties and manufacturing inconsistencies. The client needed a reliable partner to provide a high-performance material solution and precision machining expertise to ensure the stents could meet stringent medical standards and perform reliably in critical applications.

SOLUTION

AIP Precision Machining leveraged its extensive experience in high-performance plastics and composites to identify the ideal material for the stents. AIP selected PEEK (Polyether Ether Ketone), known for its exceptional strength, biocompatibility, and resistance to both chemicals and radiation. Utilizing advanced CNC machining techniques, AIP produced stents with precise tolerances and superior surface finishes, ensuring consistent performance and durability.

The collaboration included rigorous testing and validation to meet all medical and regulatory requirements.



Dr. Rohit Khanna,
Halifax Medical Center

The technical expertise, along with personal attention and prompt responses make AIP a valuable company to work with.

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TO
50%
CHANCE OF
COMPLICATION
OR DEATH

Conclusion

Polyacetal Delrin® stands as a cornerstone material in medical device manufacturing through its exceptional combination of mechanical strength, chemical resistance, and dimensional stability. Medical manufacturers benefit from its versatile processing options, whether through precision CNC machining or high-volume injection molding, while maintaining strict tolerances and consistent performance. These capabilities, paired with excellent wear resistance and biocompatibility, make Delrin® an optimal choice for demanding medical applications ranging from surgical instruments to advanced drug delivery systems.

Medical device manufacturers must navigate complex regulatory requirements while maintaining the highest quality standards for Delrin® components.

Strict adherence to FDA regulations, proper sterilization protocols, and comprehensive quality control measures ensure reliable performance and patient safety across all applications. The continued advancement of medical device technology, supported by Delrin®'s proven track record, promises enhanced patient care through reliable, precise, and safe medical components.

Achieve Precision and Biocompatibility with Delrin® Machining by AIP – our ISO 13485-certified facilities ensure top-quality Delrin® components for medical devices, and we invite you to request a quote today to get started on your project.

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MEDICAL DEVICE MANUFACTURING: PRECISION MACHINING FOR ORTHOPEDIC IMPLANTS

Orthopedic implant manufacturing is entering a new era—one defined by personalization, biocompatibility, and material innovation. With the global joint reconstruction market alone expected to surpass \$25 billion by 2030, the demand for implants that are lighter, longer-lasting, and more compatible with human anatomy is accelerating.

At the core of this advancement lies the strategic use of high-performance polymers such as PEEK, CFR-PEEK, and UHMWPE—materials engineered to deliver metal-like strength with bone-like flexibility and imaging compatibility. Unlike titanium or cobalt-chromium, these polymers allow for radiolucency, lower patient rejection risk, and enhanced design freedom.

For over four decades, AIP Precision Machining has supported leading medical OEMs with implant-grade polymer components, machined to exacting tolerances under ISO 13485 certification. Our specialization in orthopedic device manufacturing ensures that every component meets the stringent regulatory, mechanical, and biological standards required in modern medicine.

Material Science: Why Polymers Are Reshaping Orthopedics

Orthopedic implants must balance durability, biocompatibility, imaging clarity, and load-bearing capacity—all within the anatomical constraints of the human body. Traditional metal implants, while strong, often create challenges: MRI interference, stress shielding, and long-term bone resorption.

In contrast, advanced polymers offer several key advantages:

- Modulus of elasticity similar to cortical bone—reducing stress shielding
- Radiolucency and MRI compatibility—enabling post-operative imaging
- Superior fatigue resistance—ideal for load-carrying, articulating components
- High wear resistance—essential for joint articulations

Key Polymers in Implant Manufacturing

Material	Key Advantages	Common Applications
PEEK	Bone-like mechanical properties, MRI compatibility	Spinal cages, trauma plates, interbody fusion devices
CFR-PEEK	Increased strength and stiffness, low weight	Bone screws, articulating implants, hip/knee replacements
UHMWPE	Exceptional wear resistance, low friction	Bearing surfaces in joint replacements (acetabular liners, tibial inserts)

These polymers are selected not just for strength—but for long-term biological integration. Their performance in vivo depends equally on surface finish, dimensional precision, and design accuracy—areas where AIP's ultra-precision capabilities are critical.

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Orthopedic implants often feature complex geometries that must interface seamlessly with bone and soft tissue. Machining tolerances frequently approach ± 0.01 mm or better, particularly in spinal and trauma systems. AIP's advanced production capabilities—including multi-axis CNC machining, live tooling, and surface finishing—ensure consistency from prototype through production.

CNC Machining of Implantable Polymers

- CNC Milling is ideal for custom joint replacements, bone plates, and structural implants with complex contours.
- CNC Turning produces cylindrical parts such as interference-fit screws, rods, and pins.
- Live Tooling integrates turning and milling in a single setup—ideal for small, precision orthopedic components.

Surface Finishing and Polishing

Surface smoothness is critical to minimize inflammation and bacterial colonization. AIP achieves $R_a < 0.02 \mu\text{m}$ finishes, ideal for articulating surfaces and implant-bone interfaces. Techniques include fine polishing, micro-deburring, and ultrasonic cleaning—performed in dedicated clean areas to avoid contamination.

ISO 13485 & FDA Compliance: Built Into Every Part

In orthopedic manufacturing, regulatory compliance is not optional—it is foundational. AIP Precision Machining operates under a fully documented ISO 13485:2016 quality management system, ensuring traceability, process control, and repeatability at every stage.

We support our clients with:

- FDA 21 CFR Part 820 compliance for Design History Files (DHF), Device Master Records (DMR), and process validations
- Full lot traceability and UDI readiness
- Controlled environment machining and packaging for implantable-grade materials
- Validation documentation support for IQ/OQ/PQ processes

Each orthopedic component is subject to in-process and final inspection using CMMs, laser scanners, and optical comparators. For 3D printed or porous-structured implants, we integrate CT scanning and digital simulation to verify internal geometries.

Personalization Through Design for Manufacturability (DFM)

Orthopedic implants are trending toward patient-specific design, and AIP works closely with OEM engineers to align design intent with machinability. Our DFM support includes:

- Design optimization for polymer machining (vs. casting or molding)
- Radii, wall thickness, and tolerance balancing for strength and manufacturability
- Advising on polymer grade selection based on load, exposure, and sterilization methods

We frequently engage at the prototyping stage, supporting low-volume test runs and accelerating time-to-market through rapid toolpath development and in-house fixturing.

The Rise of Additive and Hybrid Implant Designs

3D printing—particularly for spinal cages and joint augmentations—has unlocked new frontiers in orthopedic innovation. AIP complements these

advances through hybrid approaches:

- Post-machining of printed parts to achieve sealing surfaces, press-fit features, and surgical attachment points
- Integration of porous structures for enhanced osseointegration while maintaining dimensional control
- Machined-in anti-rotation and locking features for implant-screw systems

- Laser scanning for curvature and surface geometry
- CT inspection for internal defect detection and porosity mapping
- Digital comparison against CAD to validate each implant's conformity

We also support our clients with validation reports, material certifications, and surface roughness data—delivered as part of each production lot or pilot run.



Materials like PEEK and ULTEM™ can be printed in limited geometries but still require precision post-processing to meet orthopedic standards. Our knowledge of thermal expansion, anisotropy, and stress-relief protocols ensures reliable mechanical outcomes.

Metrology: Measuring What Matters

Precision in orthopedic manufacturing is measured not just in microns, but in clinical outcomes. AIP's metrology lab employs:

- Multisensor CMMs for dimensional verification

Future Trends: Smart Implants, Bioprinting, and Nano-Coatings

The future of orthopedic implants is becoming smarter, more personalized, and biologically integrated. Developments currently reshaping the field include:

- Smart Implants with embedded sensors to monitor strain, load, and healing progression in real-time



Read the full article here:

- Bioprinting of scaffold materials for bone grafts and fusion aids
- Nanostructured coatings that reduce infection risk and stimulate osteoblast activity

While many of these technologies are still emerging, AIP's machining and inspection platforms are built to accommodate next-generation geometries and hybrid assemblies—ensuring clients remain ready for regulatory and market demands.

Conclusion

Orthopedic implant innovation is driven by the intersection of biocompatible materials, regulatory rigor, and micro-scale precision. At AIP Precision Machining, we deliver all three.

Whether machining high-strength CFR-PEEK rods, shaping complex joint implants, or finishing articulating components to sub-micron smoothness, AIP ensures every part is ready for the human body—engineered to heal, built to endure.





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