

A revolution in dental implantology

With INPERIO, the Spain-based manufacturing company Nanoker Research is entering the ceramic implant market with the goal of revolutionising dental implantology. In order to achieve this, the company utilises two specific materials: a bio-ceramic composite on the one hand and a specific bacteriostatic bioglass coating on the other. In this interview with *ceramic implants*, Lidia M. Goyos Ball, medical devices division manager at Nanoker, talks about the advantages of the company's novel system.

First of all, what type of implant is INPERIO?

INPERIO is an all-ceramic monobloc dental implant made of our outstanding bioceramic composite. Only the inner screws (prosthetic or accessory screws), which do not come into direct contact with the body or bodily fluids during their expected use, are metallic (Ti-6Al-4V ELI, Grade 23).

For INPERIO, you utilise bioceramic composite and a bacteriostatic bioglass coating. What is so special about these materials?

Titanium implants made from Ti-6Al-4V currently make up 86.2% of all implants. Although mechanically reliable, they present various drawbacks, such as poor aesthetics, allergies, peri-implantitis and the release of complex metal alloy particles. Our bioceramic composite combines ceria-stabilised zirconia and alumina (Ce-TZP/Al) and is aesthetic by nature. This material's fracture toughness is superior to that of other ceramic materials owing to its intrinsic reinforcement mechanism, associated with its phase transformation, called transformation toughening or stress-induced martensitic transformation. Also, this ceramic does not suffer from hydrothermal phase transformation or ageing, which affects conventional yttria-stabilised zirconia (3Y-TZP). Moreover, Ce-TZP/Al exhibits some plastic deformation (ceramic ductility), a key feature in modern implant design. Beyond the well-proven preventive adhesion properties of our composite, which leads to enhanced soft-tissue attachment, our INPERIO system will incorporate a glassy coating on the transgingival abutment in the near future, once the regulatory certification process of our bacteriostatic bioglass is complete. This material acts as a biological seal, prevents the accumulation of bacterial plaque and guarantees preservation of bone, which is the main cause of long-term failure of conventional implants. It has been proved to prevent bacterial dysbiosis in the peri-implant sulcus in comparison with both titanium and 3Y-TZP.



What are INPERIO's properties regarding loading and biocompatibility?

INPERIO is the first ceramic solution that mechanically qualifies for implant insertion torque values up to 50 Ncm and screw-retained prosthetic solutions based on a ceramic multi-unit abutment termination, whereas other ceramic systems recommend not exceeding 35 Ncm, which does not allow immediate loading. Clinically speaking, INPERIO is suitable for immediate loading protocols and direct screwing to the implant with primary stability, even in extremely compromised cases. In terms of biocompatibility, INPERIO has similar success rates to titanium implants (>95%). Owing to its optimum surface roughness ($Sa = 1.4 \mu m$), there is no need to perform additional aggressive surface treatments to favour osseointegration. In fact, histological studies show that the degree of osseointegration in terms of bone-implant contact is similar to that of titanium implants. In addition, INPERIO's bioceramic composite (being a ceramic material) resists corrosion and wear and has high chemical stability. Its biocompatibility and enhanced soft-tissue attachment (anatomical emergence profile) are

outstanding. Moreover, we have demonstrated, in *in vivo* tests in dogs, that the accumulation of plaque and the dysbiosis in the peri-implant sulcus are much lower in the case of INPERIO implants when compared with commercially available titanium or zirconia implants—and especially in the case of preventive bioglass-coated INPERIO implants.

What kind of connection do you utilise?

Being a monobloc ceramic implant, INPERIO allows clinicians to follow the recommended one abutment–one time protocol that is applied in the aesthetic zone to prevent soft-tissue damage owing to repetitive abutment insertion. Furthermore, its design avoids micro-movements and bacterial microfiltration in the implant–abutment gap. INPERIO presents a platform switching arrangement and a concave emergence to jointly support and give space to the soft tissue. It also has a multi-unit connection, which allows the correction of disparallelisms of up to 25° between implants, using straight or dynamic screws and rotatory or anti-rotational systems for multiple and single restorations, respectively. We bring together a real screw-retained connection for single and multiple prosthetic restorations and ceramic biological advantages for the aesthetic zone, which cover even the most challenging cases. Our connection also means that the prosthetic workflow is exactly the same as with titanium implants: the one abutment–one time procedure, immediate provisionalisation on our multi-unit termination and immediate loading are possible. Protocols that have proved to be clinically successful do not need to be changed, but may be improved by using the most biologically friendly implant materials.

Why should clinicians offer their patients INPERIO?

Owing to its composition, design and optimised processing conditions, INPERIO has significant advantages over most solutions currently available. Its unique mechanical properties allow, for the first time in ceramic implantology, the use of the same workflow as that for titanium implants in terms of both surgical procedure and multiple prosthetic restorations.

Moreover, INPERIO is available in different diameters (3.30, 3.75 and 4.20 mm) to respect the patient's bone and provide an anatomical emergence profile for the prosthetic restoration. Our narrow-diameter implants (3.3 mm) are ideal for compromised aesthetic restorations. INPERIO shows extraordinary bone and gingival biocompatibility and outstanding mechanical properties, and it presents superior ageing properties to biomedical-grade 3Y-TZP. Its bending moment (250 Ncm in the worst case) and fatigue limit (125 Ncm, in the worst case) values prove it reliable to survive oral cavity forces in the long term. Also, its tri-edge, self-tapping, compressive, bone-level/tissue-level and domed apical design improves implant–bone interactions and stability. In a nutshell, the INPERIO system combines the biological advantages of ceramics with the most outstanding clinical protocols for the aesthetic zone and tissue preservation while also effectively improving peri-implantitis prevention. It is a ceramic implant with the advantages of titanium solutions.

When and where will it be available for clinicians?

We predict that it will be available during the second half of 2022. Also, the next steps towards market entry include covering all the necessary regulatory validations towards CE mark approval according to the new EU Medical Device Regulation (EU MDR 2017/745). In addition, we are already working on our next product, a two-piece all-ceramic implant with the versatility of the most advanced two-piece titanium implants, and we are performing the necessary certification actions to get our bioglass coating to market as soon as possible, with the intention of including it on our proprietary products and on those of any interested third parties so that society as a whole can benefit from it.

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