Trabecular Metal™ Technology

The Best Thing Next to Bone™

Introducing osseoincorporation to implant dentistry.

zimmer | dental

TRABECULAR METAL TECHNOLOGY

Trabecular Metal **Technology is an innovative material utilized by Zimmer for over 15 years in implantable orthopaedic devices. Uses of *Trabecular Metal* Material are varied and have included joint reconstruction, bone void filling and soft tissue repair.[1-3] Zimmer Dental is currently working on multiple ways to integrate *Trabecular Metal* Technology into its oral rehabilitation portfolio.**

What is Trabecular Metal Technology?

Trabecular Metal Technology is a three-dimensional material, not an implant surface or coating. Its structure is similar to cancellous bone.[4-6]

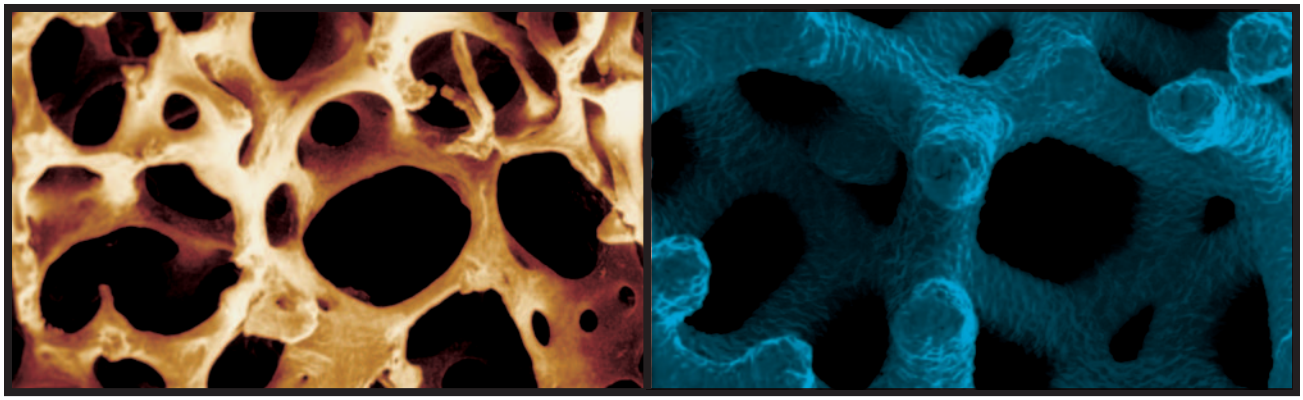

Figure 1 *Trabecular Metal* Material's structure is similar to cancellous bone[4-6]

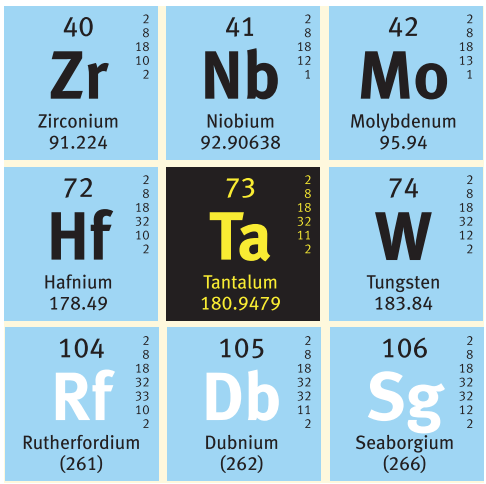

Figure 2 Tantalum is element 73 in the periodic table

Tantalum

Trabecular Metal Material is made of tantalum, element number 73 in the periodic table. Tantalum is a highly biocompatible and corrosion-resistant metal[7-11] used in various implantable devices for over 60 years,[12-16] including a dental implant in the 1940s.[16] Per-Ingvar Brånemark, known as the father of modern dental implantology, conducted osseointegration research in the 1950s utilizing tantalum.[17]

While the highly biocompatible and passive characteristics of tantalum were documented long ago, its cost and methods of production limited its use[12] until the late 1990s. Since then, hundreds of thousands of Zimmer *Trabecular Metal* Implants have been sold.[18]

How is Trabecular Metal Material Made?

Trabecular Metal Material is fabricated in Zimmer's TMT facility in Parsippany, New Jersey. The *Trabecular Metal* material process demands strict specifications for pore size, shape and interconnectivity to ensure a cancellous bone-like structure is obtained. Utilizing a thermal deposition process, elemental tantalum is deposited onto a substrate, creating a nanotextured surface topography to build *Trabecular Metal* Material, one atom at a time. This proprietary process utilizes the physical and biological properties of tantalum to create a unique material that has a structure similar to cancellous bone.[4-6]

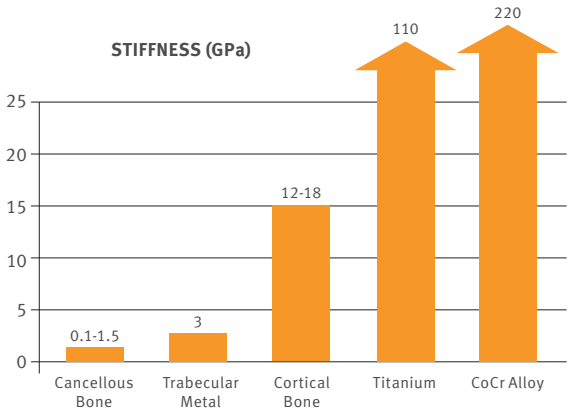

Figure 4 *Trabecular Metal* Material's modulus of elasticity (2.5-3.9 GPa) is closer to both cancellous bone (6.8 GPa) and cortical bone (13-17 GPa) than titanium (106-115 GPa), cobalt chromium (210 GPa) or stainless steel (230 GPa).[4,5]

Figure 5 Ductility without mechanical failure[19]

Figure 3 Numerous Zimmer Implants contain *Trabecular Metal* Material

Figure 6 *Trabecular Metal* Material forms a frictional interface with bone[20-23]

Material Properties

Trabecular Metal Material has a low modulus of elasticity (2.5-3.9 GPa) closer in value to cancellous bone than titanium (106-115 GPa).[4,5] In compression testing, *Trabecular Metal* Material exhibits high ductility without mechanical failure.[19*]

The *Trabecular Metal* Material has been demonstrated to contribute to the primary stability of the implant based on in vitro insertion torque testing.[20-23]

*NOTE: In the dental implant configuration, the overall compression strength and elasticity will be a function of multiple materials.

POTENTIAL FOR BONE INGROWTH A

Topography

A glimpse inside *Trabecular Metal* Material reveals its uniform three-dimensional cellular architecture with up to 80% porosity.[2-4,6,24,25] The entire surface area of *Trabecular Metal* Material exhibits a nanotextured topography.[26,27]

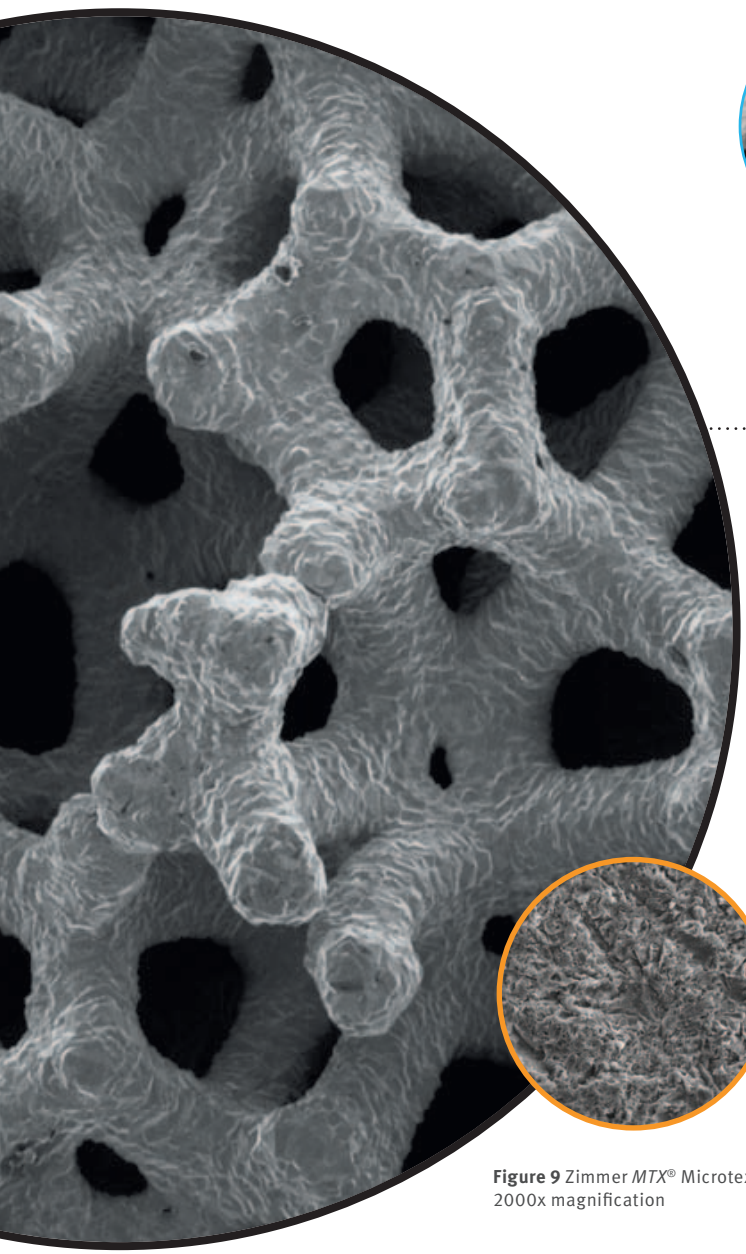

Figure 7 Three-dimensional uniformity with up to 80% porosity[2-4,6,24,25]

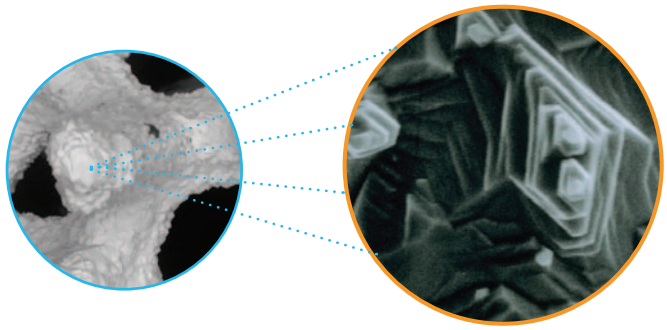

Figure 8 Nanotextured surface topography of *Trabecular Metal* struts

Osseoincorporation

Conventional textured or coated implant surfaces achieve bone-to-implant contact, or ongrowth.[17] However, *Trabecular Metal* Material's consistent, open and interconnected network of pores is designed for both ongrowth AND ingrowth, or osseoincorporation.[2,4,24] Bone has the potential to grow onto the nanosurface of the *Trabecular Metal* Material, into its interconnected pores and around its struts.[4,5,25,28,32]

Figure 9 Zimmer *MTX*® Microtexture at 2000x magnification

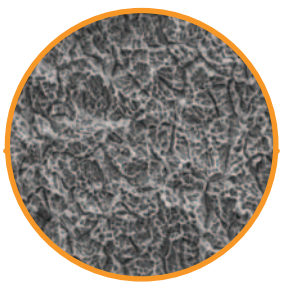

Figure 10 Straumann SLActive™ at 2000x magnification

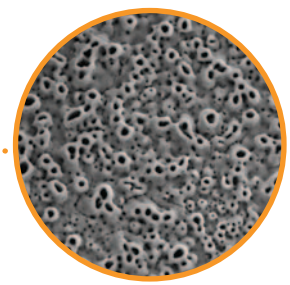

Figure 11 Nobel Biocare TiUnite® at 2000x magnification

Traditional Implant Surfaces Have the Potential for Bone Ongrowth,[17]
But Not Bone Ingrowth

AS WELL AS ONGROWTH

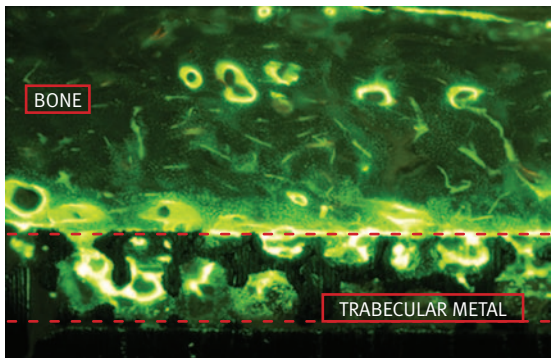

Figure 12 Documented ingrowth in canine mandible

Bone Ingrowth in Canine Mandibular Models

In a study of *Trabecular Metal* Implants placed in canine mandibular models, evidence of ingrowth by maturing bone has been documented as early as two weeks after implantation.[33,34] Further research is required to determine the rate of ingrowth and its effects on secondary stability in human dental applications.

While other manufacturers have tried to mimic the attributes of *Trabecular Metal* Technology, sintered bead and other conventional porous coatings and materials differ significantly from *Trabecular Metal* Material's high degree of interconnected porosity, low modulus of elasticity and consistency in pore size and shape.[24,29-31,35-37]

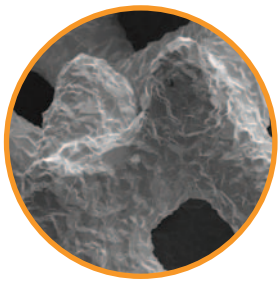

Figure 13 Zimmer *Trabecular Metal* at 500x magnification

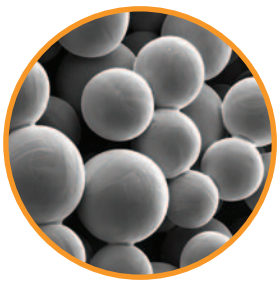

Figure 14 Sybron Endopore® at 500x magnification

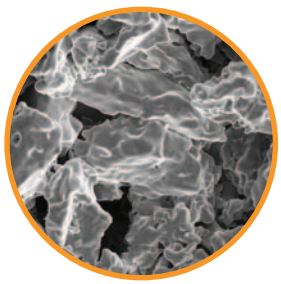

Figure 15 Zimmer *CSTi*™ at 500x magnification

Conventional Three-Dimensional Surfaces Do Not Have the Interconnected, Cancellous Porosity of *Trabecular Metal* Material[24,29-31,35-37]

The cancellous-like structure, interconnected porosity and bone ingrowth potential are a unique combination of attributes that contribute to the osteoconductive properties of *Trabecular Metal* Technology.[1-6,24,25]

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