Cancellous-Structured Titanium™ (CSTi™)
An optimal structure for bone ingrowth and fixation
“We have evidence of bone remodeling and growth into the porous coating, CSTi, and evidence of large surface areas of attachment ... all in human bone.”

- Roy Bloebaum, PhD.
CSTi™ Porous Coating
Structurally similar to human bone

CSTi porous coating combines the excellent biocompatibility of titanium with an optimal structure for bone ingrowth.

CSTi is manufactured through a proprietary process that sinters commercially pure titanium powder onto a titanium or CoCr alloy substrate. During the process, pores are created. This results in a unique porous coating that has optimally-sized, interconnected pores to allow bone ingrowth and a fine micro-roughness to provide secondary fixation.

The CSTi process was originally developed for a titanium alloy substrate. The Sinterlock™ process was developed to apply CSTi onto CoCr-alloy femoral knee components. This bimetal combination was a major advancement that combined the biocompatible properties of CSTi on the bone-contacting side of the implant with excellent wear properties of CoCr for the bearing surface.

Our implant designs are well matched with the CSTi porous coating technology. We offer CSTi options with several of our product lines, including: the Natural-Knee® System, Natural-Hip™ and APR® hip stems, and Converge® CSTi acetabular porous components.

Cancellous-Structured Titanium refers to the microscopic appearance of CSTi porous coating. CSTi is structurally similar to human cancellous bone and provides interconnected pores for bone ingrowth.

CSTi™ Porous Coating
Structurally similar to human bone

(100:1) Human cancellous bone. Pore size 400-500 µm. Pore volume 60-77%.

(100:1) CSTi. Pore size 480-560 µm. Pore volume 52-58%.

Why CSTi Works
— Excellent biocompatibility of titanium
— Optimal structure for bone ingrowth
— Fine micro-roughness for secondary fixation
— Sintering process results in excellent strength and fatigue properties
Clinical Experience
Over 15 years of clinical success

<table>
<thead>
<tr>
<th>Date</th>
<th>First Author</th>
<th>Implant Type</th>
<th>Number of Implants</th>
<th>Implantation Time</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>Bloebaum</td>
<td>Tibial baseplate</td>
<td>1 CSTi</td>
<td>19 mos. CSTi</td>
<td>67% ABI* (CSTi) 9% ABI (CoCr Beads) 22% ingrowth** (CSTi) 0% ingrowth (CoCr beads)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 CoCr</td>
<td>25 mos. CoCr beads</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>Hofmann</td>
<td>Natural-Knee tibia and femur</td>
<td>183</td>
<td>2 - 4 yrs.</td>
<td>96% good or excellent results</td>
</tr>
<tr>
<td>1996</td>
<td>Baldwin</td>
<td>Natural-Knee</td>
<td>109</td>
<td>3 - 5 yrs.</td>
<td>96% good or excellent results 82% no lucencies</td>
</tr>
<tr>
<td>1997</td>
<td>Evanich</td>
<td>Natural-Knee Patella</td>
<td>212</td>
<td>6 - 10 yrs.</td>
<td>96% survivorship No lucencies</td>
</tr>
<tr>
<td>1997</td>
<td>Hofmann</td>
<td>Bone plug</td>
<td>36</td>
<td>Up to 1 yr.</td>
<td>24% ingrowth</td>
</tr>
<tr>
<td>1997</td>
<td>Bloebaum</td>
<td>Acetabular shell</td>
<td>7</td>
<td>38 ± 21 mos.</td>
<td>84% ABI 12% ingrowth</td>
</tr>
<tr>
<td>1997</td>
<td>Bloebaum</td>
<td>Tibial baseplate</td>
<td>8</td>
<td>47 ± 36 mos.</td>
<td>73% ABI 6% ingrowth</td>
</tr>
<tr>
<td>1998</td>
<td>Bloebaum</td>
<td>Natural-Knee Patella</td>
<td>11</td>
<td>45 ± 36 mos.</td>
<td>86% ABI 13% ingrowth</td>
</tr>
<tr>
<td>2000</td>
<td>Hofmann</td>
<td>Natural-Hip</td>
<td>90</td>
<td>81 ± 21 mos.</td>
<td>No subsidence or loosening</td>
</tr>
<tr>
<td>2000</td>
<td>Kang</td>
<td>APR-II Hip</td>
<td>99</td>
<td>45 ± 36 mos.</td>
<td>99% good or excellent results 94% no lucencies</td>
</tr>
<tr>
<td>2001</td>
<td>Hofmann</td>
<td>Natural-Knee</td>
<td>176</td>
<td>10 - 14 yrs.</td>
<td>10-yr survivorship: 99.1% femoral 99.6% tibial 95.1% patellar</td>
</tr>
</tbody>
</table>

*ABI (appositional bone index) is a measure of the percent of bone in direct contact with the porous surface.

**Ingrowth is determined by the percent volume of bone in the total volume of pores available. This is determined through BSE (back-scattered electron microscopy).

CSTi porous coating has over 15 years of clinical experience with demonstrated success in both retrieval and long-term clinical studies.

The excellent results in these published clinical studies confirm the basic science research supporting CSTi.

Long-term follow-up x-rays and retrieval analysis clearly demonstrate successful fixation and bone ingrowth of CSTi-coated components.
Post-mortem Retrieval Analysis of CSTi-coated Hemispherical Shell†

CSTi-coated hemispherical acetabular shell and Natural-Hip porous-coated collared stem. 11-year follow-up.
(Radiograph courtesy of Dr. A Hofmann, University of Utah, Salt Lake City).

Post-mortem Retrieval Analysis of Natural-Knee Tibial Baseplate†

Natural-Knee 10-year follow-up.
(Radiograph courtesy of Dr. A Hofmann, University of Utah, Salt Lake City).

† Retrieval micrographs courtesy of Dr. Roy Bloebaum, Bone and Joint Research Laboratory, University of Utah.
CSTi vs. Other Porous Coatings
The clinical results speak for themselves

<table>
<thead>
<tr>
<th>Bone Ingrowth / Biologic Fixation Comparison</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="CSTi" /></td>
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</table>

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Centerpulse</th>
<th>Howmedics Osteonics J&amp;J Depuy</th>
<th>Zimmer</th>
<th>Biomet</th>
<th>Zimmer</th>
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</thead>
<tbody>
<tr>
<td>Pore Size</td>
<td>400 - 600 µm</td>
<td>variable</td>
<td>-</td>
<td>variable</td>
<td>300 µm</td>
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<tr>
<td>Pore Volume</td>
<td>50 - 60%</td>
<td>35%</td>
<td>68%</td>
<td>variable</td>
<td>70%</td>
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<tr>
<td>Coating Material</td>
<td>Ti</td>
<td>CoCr</td>
<td>Ti</td>
<td>Ti</td>
<td>Ta</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Retrieval Results</th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>% - Ingrowth Tibial Baseplates</td>
<td>6 - 22%(^4,9)</td>
<td>6 - 9%(^4,15)</td>
<td>9.5%(^6,16)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>ABI Tibial Baseplates</td>
<td>73%(^9)</td>
<td>36%(^15)</td>
<td>27%(^6,16)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>% - Ingrowth Acetabular Shells</td>
<td>12%(^1)</td>
<td>0 - 10%(^17)</td>
<td>12%(^18)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>ABI Acetabular Shells</td>
<td>84%(^1)</td>
<td>NA</td>
<td>0-55%(^18)</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

| Clinical Advantages and Features | | | | |
|----------------------------------|---|---|---|
| Optimal Pore Size | ■ | ■ | ■ |
| Optimal Pore Volume | ■ | ■ | ■ |
| Bone Ingrowth Coating | ■ | ■ | ■ |
| Micro-Surface Texture | ■ | ■ | ■ |
| Bimetal (Ti coating on CoCr) | ■ | ■ |
| Interconnected Pores | ■ | ■ | ■ |
| Coating does not Dissociate | ■ | ■ | ■ |

*Trabecular Metal implants have no substrate. Polyethylene is molded directly onto the metal structure, which also eliminates the possibility of modularity.
References


Knees
Apollo® Knee System
Classic condylar knee replacement system
Durasul® Tribological System
Highly crosslinked polyethylene that resists wear and aging
Natural-Knee® System
Anatomic design for superior clinical results
UnSpacer™ Knee System
No bone cuts. No compromises.

Severe Revision/Limb Salvage
MOST Options™ System
Modular knee and hip options for severe bone loss, trauma and revision

Hips
Alloclassic® (Zweymüller™) Hip
Classic proven design with superior clinical results
Allofit™ Acetabular Cup System
Unique RidgeLock™ surface designed for easy implantation and stability
Apollo® Hip System
Designed for optimal results with low-demand patients
APR® Anatomical Hip System
The anatomic solution for bone matching
CLS™ (Spotorno™) Hip System
The standard of proximal press-fit design
Converge® CST™ Porous Acetabular Cup System
Where technology and experience meet
Durasul® Tribological System
Highly crosslinked polyethylene that resists wear and aging
FracSure™ Hip System
A classic design for hip fractures
Metasul®® Metal-on-Metal Acetabular System
Over 15 years of clinical results & 200,000 implantations worldwide
MS-30™ Hip
A highly polished cemented stem
Natural-Hip™ System
A comprehensive system with a natural approach
Precedent™ Revision Hip System
A better solution for revision hips
SL Revision™ Hip System
A stable revision design with extensive sizes

Upper Extremities
Anatomical™ Shoulder System
Multiple adjustments of inclination & retroversion with the potential for precisely restored anatomy
GSB® Elbow System
A nonconstrained design with 21 years of clinical results
Select® Shoulder System
TSA and fracture management with offset head options