SI-BONE, Inc.
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Re: iFuse, iFuse 3D, iFuse TORQ, and iFuse Bedrock Granite Implant Metal Content

Dear Sir or Madam,

Thank you for your inquiry regarding the material composition of the iFuse, iFuse 3D, iFuse TORQ, and/or iFuse Bedrock Granite Implants and/or the possibility of developing sensitivity to the metal ions within these implants.

iFuse Implants are constructed from a core of titanium alloy (Ti-6Al-4V ELI) and are coated with commercially pure (CP) titanium. The Internal Screw, Deformity Head, and Set Screw of the iFuse Bedrock Granite implant are made from the same titanium alloy (Ti-6AI-4V ELI) as the iFuse implant. The iFuse 3D implants, iFuse TORQ implants, and iFuse Bedrock Granite Implant Sleeves are additively manufactured from titanium alloy (Ti-6Al-4V ELI) powder. The ASTM Standards for the materials used to manufacture the implants allow for trace amounts of other elements to be present in the metal.

The CP titanium and titanium alloys are manufactured according to American Society for Testing and Materials (ASTM) International specifications. The Ti-6Al-4V ELI titanium alloy is manufactured according to the specifications found in ASTM F136.[1] The CP Titanium Powder coating is manufactured to the specifications found in ASTM F1580. [2] The Ti-6AI-4V Titanium Alloy powder conforms to the specifications of ASTM F3001.[3] Implants manufactured from these base materials are routinely tested by the manufacturers to confirm that the products conform to these ASTM standards. ASTM standards allow trace amounts of other materials[4,5] within the metal samples.

Titanium and titanium alloys are commonly used in medical devices. Medical implants manufactured from alloy compositions covered by ASTM F136, F1580 and F3001 have a long history of successful clinical application in soft tissue and bone in humans. Titanium alloys demonstrate favorable material properties compared to other metals. In addition, titanium is significantly less likely to stimulate an immune response compared to other metals such as nickel, cobalt, and chromium. However, it has been documented that, while uncommon, individuals may develop sensitivity to titanium and other metal ions such as beryllium, tantalum and vanadium.[6-8]

SI-BONE recently had testing performed by an independent third-party laboratory to identify and quantify the amount of trace metals used to manufacture iFuse, iFuse 3D, iFuse TORQ, and iFuse Bedrock Granite Implants. The materials used to manufacture all iFuse implants contain trace amounts of several metals (see tables below). This independent testing also confirmed that the iFuse, iFuse 3D, iFuse TORQ, and iFuse Bedrock Granite Implant compositions adhere to the ASTM standards (see Tables 1&2).

If a patient is suspected of having sensitivity to metal, the physician may consider having the patient tested for metal sensitivity with a test such as a MELISA test (Memory Lymphocyte Immunostimulation Assay, http://www.melisa.org) [9,10] or the LTT (Lymphocyte transformation test, https://www.orthopedicanalysis.com/)[11,12] prior to implanting the SI-BONE Implants. MELISA and LTT are both blood tests that assess type IV hypersensitivity to metals and low-molecular weight allergens.

Sincerely,

W. Carlton Reckling, M.D.
VP of Medical Affairs
SI-BONE, Inc.

Table 1. Material Compositions of the iFuse, iFuse 3D, & TORQ Implants
(Includes ASTM Specifications and Comprehensive Analysis by an Independent Laboratory)
All values in percent by weight

	iFuse				iFuse 3D & iFuse TORQ	
	Ti-6Al-4V Titanium Alloy Core		CP Titanium Powder Coating		Ti-6Al-4V Titanium Alloy Powder	
Element	**ASTM F136 Specifications** (including tolerances)	**Test Results Percent Weight** (300213)	**ASTM F1580 Specifications** (including tolerances)	**Test Results Percent Weight** (300213)	**ASTM F3001 Specifications** (including tolerances)	**Test Results Percent Weight** (300652) e
Nitrogen	0.07 (max)	0.0013	0.04 (max)	0.028	0.05 (max)	0.013
Carbon	0.10 (max)	0.03	0.05 (max)	0.3a	0.08 (max)	0.02
Hydrogen	0.014 (max)	0.0027	0.032 (max)	0.026	0.012 (max)	0.0067
Iron	0.35 (max)	~0.2	0.25 (max)	0.0073	0.25 (max)	0.16
Oxygen	0.15 (max)	0.15	0.40 (max)	0.33	0.13 (max)	0.13
Aluminum	5.1 - 6.9	5.98	0.09 (max)	0.002	5.50 – 6.50	6.38
Vanadium	3.35 - 4.65	4.15	d	0.0037	3.50 – 4.50	4.02
Yttrium	d	<0.02	d	<0.02	0.005 (max)	<0.02c
Silicon	d	0.021	0.06 (max)	0.0081	d	0.013
Chlorine	d	~0.0002	0.20 (max)	~0.3b	d	0.000051
Sodium	d	0.000061	0.50 (max)	0.033	d	0.000014
Nickel	d	0.0052	d	0.00022	d	0.0084
Chromium	d	0.0041	d	0.00017	d	0.014
Cobalt	d	0.000091	d	0.00052	d	0.00099
Copper	d	0.0014	d	0.003	d	0.00047
Molybdenum	d	0.0031	d	0.00064	d	0.0023
Titanium	Balance	Balance	Balance	Balance	Balance	Balance

a Not confirmed with additional testing. Material Certification for Carbon verified at 0.006% by weight.
b Not confirmed with additional testing. Material Certification for Chlorine verified at 0.02% by weight.
c Not confirmed with additional testing. Test Report 300533 includes <0.005 Yttrium.
d TOE (total other elements) < 0.40% by weight; OEE (other elements each) < 0.10% by weight.
e Elemental Analysis for Ti-6Al-4V Titanium Alloy Powder performed for iFuse 3D, per ASTM F3001, is applicable to iFuse TORQ

Table 2. Material Compositions of the Granite Implant Components
(Includes ASTM Specifications and Comprehensive Analysis by an Independent Laboratory)
All values in percent by weight

	Internal Screw [g], Deformity Head, and Set Screw		**Sleeve**	
	Ti-6Al-4V Titanium Alloy		**Ti-6Al-4V Titanium Alloy Powder**	
Element	**ASTM F136 Specifications** (including tolerances)	**Test Results Percent Weight** (300213) [f]	**ASTM F3001 Specifications** (including tolerances)	**Test Results Percent Weight** (300652) [e]
Nitrogen	0.07 (max)	0.0013	0.05 (max)	0.013
Carbon	0.10 (max)	0.03	0.08 (max)	0.02
Hydrogen	0.014 (max)	0.0027	0.012 (max)	0.0067
Iron	0.35 (max)	~0.2	0.25 (max)	0.16
Oxygen	0.15 (max)	0.15	0.13 (max)	0.13
Aluminum	5.1 - 6.9	5.98	5.50 – 6.50	6.38
Vanadium	3.35 - 4.65	4.15	3.50 – 4.50	4.02
Yttrium	[d]	<0.02	0.005 (max)	<0.02[c]
Silicon	[d]	0.021	[d]	0.013
Chlorine	[d]	~0.0002	[d]	0.000051
Sodium	[d]	0.000061	[d]	0.000014
Nickel	[d]	0.0052	[d]	0.0084
Chromium	[d]	0.0041	[d]	0.014
Cobalt	[d]	0.000091	[d]	0.00099
Copper	[d]	0.0014	[d]	0.00047
Molybdenum	[d]	0.0031	[d]	0.0023
Titanium	Balance	Balance	Balance	Balance

a Not confirmed with additional testing. Material Certification for Carbon verified at 0.006% by weight.
b Not confirmed with additional testing. Material Certification for Chlorine verified at 0.02% by weight.
c Not confirmed with additional testing. Test Report 300533 includes <0.005 Yttrium.
d TOE (total other elements) < 0.40% by weight; OEE (other elements each) < 0.10% by weight.
e Elemental Analysis for Ti-6Al-4V Titanium Alloy Powder performed for iFuse 3D, per ASTM F3001, is applicable to the iFuse Bedrock Granite Sleeve
f Elemental Analysis for Ti-6Al-4V Titanium Alloy performed for iFuse , per ASTM F136, is applicable to the iFuse Bedrock Granite Internal Screw, Deformity Head, and Set Screw
g The Granite Internal Screw Development concludes with Type 2 Anodization, where a thin layer of Titanium Oxide is formed on the surface of the implant. Any introduction of additional Titanium or Oxygen to each elemental % weight is nominal and does not significantly affect overall metal composition.

References

1. ASTM F136-13 – Standard Specification for Wrought Titanium-6Aluminum-4Vanadium ELI (Extra Low Interstitial) Alloy for Surgical Implant Applications (UNS R56401).
2. ASTM F1580-18 – Standard Specification for Titanium and Titanium-6 Aluminum-4 Vanadium Alloy Powders for Coatings of Surgical Implants.
3. ASTM F3001-14 – Standard Specification for Additive Manufacturing Titanium-6 Aluminum-4 Vanadium ELI (Extra Low Interstitial) with Powder Bed Fusion.
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