Additionally, machining the ferrule (typically from pure titanium) to provide a high tolerance gap between the ferrule and the insulator (about 10-50 μm) which is necessary to achieve a quality braze joint is demanding and costly. Furthermore, if the gap is not maintained during the brazing process, or if the brazing process itself is not properly performed, a weak joint may be formed that can lead to premature failure of the implantable device.

For these and other reasons there is a need for the embodiments of the present disclosure.

Summary of Invention

In accordance with a first aspect of the embodiment, there is provided a method of attaching a feedthrough to a titanium housing of an implantable medical device. The method includes applying a sinter paste onto a surface of the housing about a perimeter of an opening through the housing, the sinter paste including a biocompatible bonding material, placing an insulator of the feedthrough onto the sinter paste so as to cover the opening, and heating the sinter paste to a temperature less than a beta-transus temperature the titanium of the housing and to a temperature less than a melting point of the biocompatible bonding material for a desired duration to form, from the sinter paste, a sinter joint which bonds the feedthrough to the housing and hermetically seals the opening.

In accordance with a second aspect of the embodiment, there is provided an implantable medical device including a housing having an opening with an opening width, a feedthough including an insulator having a bottom surface and side surfaces and having an insulator width between opposing side surfaces that is greater than the opening width, and a sinter joint between at least one of the bottom surface, top surface, and side surfaces of the insulator and the housing which hermetically seals the insulator to the housing.

In accordance with a third aspect of the embodiment, there is provided a method of attaching a feedthrough device to hermetically seal an opening in a titanium housing of an implantable medical device. The method includes applying a sinter paste about a perimeter of the opening, the sinter paste including a biocompatible bonding material, positioning the feedthrough on the sinter paste to cover the opening, the feedthrough having a width greater than a

width of the opening, heating the sinter paste to a temperature less than a β-transus temperature of the titanium of the housing and less than a melting point of the biocompatible bonding material for a duration which to limit an average grain size of the titanium to not greater than 100 um and to form a sinter joint from the sinter paste that bonds the feedthrough to the housing and hermetically seals the opening.

Brief Description of the Drawings

The accompanying drawings are included to provide a further understanding of embodiments and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments and together with the description serve to explain principles of embodiments. Other embodiments and many of the intended advantages of embodiments will be readily appreciated as they become better understood by reference to the following detailed description. The elements of the drawings are not necessarily to scale relative to each other. Like reference numerals designate corresponding similar parts.

Figure 1 generally illustrates an example of an implantable medical device according to one embodiment.

Figures 2 illustrates a feedthrough device in an implantable in accordance with the prior art.

Figure 3 illustrates a cross-sectional view of a feedthrough in an implantable medical device in accordance with one embodiment.

Figure 4 is cross-sectional view illustrating a feedthrough in an implantable medical device including according to one embodiment.

Figure 5 is cross-sectional view illustrating a feedthrough in an implantable medical device including according to one embodiment.

Figure 6 is a block and schematic diagram illustrating a method of attaching a feedthrough to a housing using sintering process according to one embodiment.