orientation of the Figure(s) being described. Because components of embodiments can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

It is to be understood that the features of the various exemplary embodiments described herein may be combined with each other, unless specifically noted otherwise.

In accordance with one embodiment of the present disclosure, a method of forming a feedthrough device for an implantable medical device is provided. A bulk insulator having a longitudinal length extending between first and second end faces is provided, the bulk insulator including one or more conducting elements extending therethrough between the first and second end faces, and having a perimeter surface along the longitudinal length. A metal, metal alloy, or cermet is deposited on the perimeter surface to form a ferrule directly on the perimeter surface of the bulk insulator. The ferrule can be joined to other components of the implantable medical device. After the metal, metal alloy, or cermet has been deposited, the bulk insulator is segmented along the longitudinal length into individual segments each having a thickness, with each individual segment forming a feedthrough device.

According to one embodiment, the perimeter surface of the bulk insulator is metallized with a metallization layer prior to depositing the metal, metal alloy, or cermet. In one embodiment, the metallization layer is of a metal selected from a group consisting of titanium, niobium, platinum, palladium, and gold, and has a thickness in a range from 0.2 μm to 10 μm.

Embodiments described herein for depositing a metal, metal alloy, or cermet on the insulator to form a ferrule directly on the perimeter surface thereof provides advantages over known processes. Depositing the metal ferrule directly on the insulator, or on a metallized layer thereon, eliminates braze and solder joints which exist between the ferrule and insulator of conventional ferrules,

elements also eliminates braze and/or solder joints between the conductive elements and the insulator and such that the entire ferrule is brazless/solderless.

In one embodiment, the insulator is preheated using a laser to a desired temperature within a range from 800 to 1500 °C prior to depositing the metal, metal alloy, or cermet on the perimeter surface. According to one embodiment, the insulator is preheated to the desired temperature in a time period ranging from 15 to 180 seconds. In one embodiment, the laser is used to ramp down a temperature of the insulator after deposition of the metal, metal alloy, or cermet thereon. Controlling the temperature of the insulator in this fashion reduces or eliminates the potential for cracking of the insulator that might otherwise result from a thermal shock during the deposition process.

Another aspect provides a method of forming a feedthrough device for an implantable medical device including providing an insulator having one or more conducting elements extending therethrough, the insulator having a perimeter edge surface, metallizing the perimeter edge surface to provide a metallized layer thereon, and depositing a metal, metal alloy, or cermet having a thickness in a range from 200 to 800 μm on the metallized layer to form a ferrule thereon and thereby form the feedthrough device. According to one embodiment, such method provides depositing the metal, metal alloy, or cermet on individual feedthrough devices in lieu of forming such devices from a bulk insulator.

Such method provides several of the advantages discussed above, including forming stronger and more consistent and uniform hermetic seals between ferrules and insulators relative to conventional solder and braze joints, and the elimination of the formation and maintenance of a high-tolerance gap between the ferrule and insulator which is required for producing convention solder and braze joints.

One embodiment provides a feedthrough for an implantable medical device including a ferrule comprising a metal, metal alloy, or cermet that is configured to be ~~jointed~~ welded to a case of the implantable device, an insulator substantially surrounded by the ferrule and sharing an interface therewith, the insulator comprising a glass or ceramic material, and conductive elements formed through the insulator providing an electrically conductive path through