A catheter comprising a catheter sleeve and a micro-thermocouple adapted to move within the sleeve, wherein the micro-thermocouple includes a first insulated conductor, wherein the first conductor has a diameter ranging from around 0.00009 inches to 0.005 inches, a second insulated conductor, and a coupled region including a bare region of the first insulated conductor coupled to a bare region of the second insulated conductor and an electrically insulative cover.
200

210

REMOVING INSULATION FROM A DISTAL END OF EACH OF THE THERMOCOUPLE CONDUCTORS

220

FORMING A THERMOCOUPLE JUNCTION AT THE DISTAL ENDS OF THE THERMOCOUPLE CONDUCTORS

230

SLIDING THE TUBE OF HEAT SHRINKABLE POLYMER MATERIAL OVER THE THERMOCOUPLE JUNCTION

240

SEALING THE THERMOCOUPLE JUNCTION BY HEATING AND MELTING THE POLYMER MATERIAL

FIG. 2
POLYMER ENCAPSULATED MICRO-THERMOCOUPLE

RELATED APPLICATIONS

[0001] The present application is a continuation of U.S. patent application Ser. No. 12/077,316, filed Mar. 17, 2008, the specification of which is incorporated herein by reference in its entirety, which is a continuation of U.S. patent application Ser. No. 10/391,531, filed Mar. 17, 2003, and issued Apr. 22, 2008 as U.S. Pat. No. 7,361,830, the specification of which is incorporated herein by reference in its entirety.

[0002] Pursuant to 35 U.S.C. § 119(e), this patent application claims the benefit of related U.S. Provisional Application No. 60/366,435 filed Mar. 21, 2002, which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0003] This patent application relates to thermocouple devices, and in particular, to a thermocouple device produced by encapsulating a thermocouple junction with a heat-shrinkable polymer coating.

BACKGROUND

[0004] A thermocouple is a bimetal junction that provides a voltage proportional to temperature. Temperature probes are often formed using thermocouples. Many applications requiring temperature probes require extremely small size.

[0005] One application for extremely small temperature probes is in the medical device industry; especially for use in catheters. For example, ablation catheters are used in non-invasive treatment of heart abnormalities. The ablation catheter is able to identify abnormal tissue growth and uses heat to remove the tissue causing the additional conduction paths. Thermal feedback is required when removing the tissue to prevent blood clots or blood boiling during the procedure. In using a temperature probe to provide this feedback, the probe must be small enough to get as near an ablation electrode as possible. Also, when used in catheters, it is desirable that a temperature probe not rupture a catheter sleeve by tearing or abrasion. Further, a probe should be electrically insulated to allow in vivo operation.

[0006] It is apparent that uses for extremely small temperature probes beyond the medical field are possible. An extremely small probe would be useful in any field where a measurement of a localized temperature variation is desired, such as, for example, the field of electronics.

[0007] What is needed is an insulated thermocouple device of extremely small size.

SUMMARY

[0008] This document discusses a catheter with an insulated micro-thermocouple device of extremely small size. The catheter comprises a catheter sleeve and the micro-thermocouple adapted to move within the sleeve, wherein the micro-thermocouple includes a first insulated conductor having a diameter ranging from about 0.0009 inches to 0.005 inches, a second insulated conductor, and a coupled region including a bare region of the first insulated conductor coupled to a bare region of the second insulated conductor and an electrically insulative cover.

[0009] This summary is intended to provide an overview of the subject matter of the present application. It is not intended to provide an exclusive or exhaustive explanation of the invention. The detailed description is included to provide further information about the subject matter of the present patent application.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In the drawings like numerals refer to like components throughout the several views.

[0011] FIG. 1 is a drawing of one embodiment of the micro-thermocouple.

[0012] FIG. 2 is a flowchart showing one method for forming the micro-thermocouple.

[0013] FIG. 3 is a drawing of showing fused embodiments of the micro-thermocouple.

DETAILED DESCRIPTION

[0014] In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and specific embodiments in which the invention may be practiced are shown by way of illustration. It is to be understood that other embodiments may be used and structural changes may be made without departing from the scope of the present invention.

[0015] As stated previously, the present application is concerned with materials and techniques used to create a sealed thermocouple of extremely small size. FIG. 1 shows one embodiment of a micro-thermocouple 100. The thermocouple junction 130 is formed from joining conductors 120, 122 of dissimilar metals. The metals comprise any of the standard metal combinations defined by the American Society of Testing and Materials (A.S.T.M.) for thermocouples. The size of the thermocouple conductors generally fall within the range of about 0.05 inches to 0.5 inches. The overall length (L) 165 of the micro-thermocouple 100 is within the
range of about 20 inches to 78 inches. One embodiment of the micro-thermocouple 100 uses polyethylene terephthalate (PET) as the polymer material. Another embodiment uses fluorinated ethylene propylene (FEP). The seal 150 is moisture resistant and electrically insulating. The insulation resistance of the seal is greater than 100 Mega-ohms when measured at 50 Volts (DC).

Fig. 1 also shows a cross section 110 of the micro-thermocouple 100. The width (w) 170 of the micro-thermocouple 100 falls within a range from about 0.005 inches to 0.011 inches. The height (h) 175 of the micro-thermocouple 100 falls within a range of about 0.003 inches to 0.01 inches. Thus, it can be seen that the micro-thermocouple can be formed within a reproducible confined shape having a height 175 less than about 0.01 inches and a width 170 less than about 0.011 inches. The final dimensions of the confined shape are determined in part by the gauge of the thermocouple conductors used. Providing the insulation by the technique described herein adds about 0.0005 inches to the width and height dimensions of a formed thermocouple junction.

Fig. 2 shows a flowchart of one embodiment of a method 200 of forming micro-thermocouple 100. At 210, insulation 140 is removed from a distal end of thermocouple conductors 120, 122. At 220, a thermocouple junction 130 is formed at the distal end of the conductors 120, 122. At 230, the tube of polymer material is slid over the thermocouple junction 130. At 240, a seal 150 is formed over the thermocouple junction 130 by heating and melting the polymer material.

Fig. 3 shows fused embodiments of the micro-thermocouple 100. A fused thermocouple prevents the possibility of recycling or reusing the thermocouple if the micro-thermocouple 100 is used in a medical device. In one embodiment a fuse 390 is placed in a thermocouple conductor 120 between a proximal end of the conductor 120 and the thermocouple joint 130. Exceeding the rating of the fuse breaks the electrical connection between the proximal end of conductor 120 and the thermocouple joint. In another embodiment, a fuse 395 is formed by placing within the thermocouple junction 130. Exceeding the rating of the fuse 395 across the thermocouple conductors 120 causes the device to lose the properties of a thermocouple.

Although specific examples have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement calculated to achieve the same purpose could be substituted for the specific example shown. This application is intended to cover any adaptations or variations of the present invention. Therefore, it is intended that this invention be limited only by the claims and the equivalents shown.

What is claimed is:

1. An catheter, comprising:
a catheter sleeve; and
a micro-thermocouple adapted to move within the sleeve,
wherein the micro-thermocouple includes:
a first insulated conductor, wherein the first conductor has a diameter ranging from around 0.0009 inches to 0.005 inches,
a second insulated conductor, and
a coupled region including a bare region of the first conductor coupled to a bare region of the second conductor and an electrically insulative cover.

2. The catheter of claim 1, wherein the second conductor has a diameter ranging from around 0.0009 inches to 0.005 inches.

3. The catheter of claim 2, wherein the insulative cover includes a dome shape end for protecting the catheter sleeve when the micro-thermocouple moves within the sleeve.

4. The catheter of claim 2, wherein the insulative cover includes fluorinated ethylene propylene.

5. The catheter of claim 2, wherein the coupled region has a junction height and a junction width, and the insulative cover has a height less than 0.0005 inches greater than the junction height and width less than 0.0005 inches greater than the junction width.

6. The catheter of claim 2, wherein the thermocouple conductors are conductors of types selected from a set of ASTM M. types T, J, K, E, S, R, and B.

7. The catheter of claim 2, wherein the junction further comprises a fuse.

8. The catheter of claim 7, wherein the fuse located between a proximal end of at least one of the thermocouple conductors and the thermocouple junction, such that exceeding an electrical rating of the fuse breaks an electrical connection between the proximal end of the conductor and the thermocouple junction.

9. The catheter of claim 2, wherein solder couples the first and second thermocouple conductors along a length of the coupled region.

10. The catheter of claim 2, wherein the coupled region has a width ranging from around 0.005 inches to around 0.011 inches.

11. The catheter of claim 10, wherein the coupled region has a height ranging from around 0.003 inches to around 0.01 inches.

12. The catheter of claim 2, wherein the insulative cover includes polyethylene terephthalate.

* * * * *