



WPI

Hydrophobic Electrodes for Electrocardiograms

Electrodes Successfully Measure Electrocardiogram Signals Under Water

BACKGROUND

Divers face many physical and health risks when they go underwater with scuba, other diving equipment, or high pressure breathing gas. In particular, they can face Decompression Sickness (DCS), a condition arising from dissolved gases coming out of solution into bubbles inside the body on depressurization.

Studies have shown that the examination of R-R intervals of an Electrocardiogram (ECG) can be used to detect the onset of DCS. Through the detection of the R peaks, the heart rate variability (HRV) of a diver can be determined, thus allowing the administration of treatment prior to additional damage. Currently, electrodes do not exist to record an ECG signal for the detection of HRV underwater.



The present invention is the successful creation of a hydrophobic electrode for appropriately detecting an ECG in the presence of water or sweat, which is also usable in a "dry" environment without the use of a conductive gel. The electrodes are sterilized, treated with PDMS/Carbon Black, and are further combined with Trifluoropropyl POSS to create a super hydrophobic surface. The electrode is cost effective, safe, easily attached to the patient or diver.

DESIGN PROCESS

- A carbon content provided by carbon black powder combines with Polydimethylsiloxane (PDMS) to form the surface of the environmentally independent electrode.
- In a four step treatment process, the carbon black/PDMS electrode is combined with Trifluoropropyl POSS (Hybrid Plastics, FL0578) to obtain further hydrophobic properties.
- A qualitative measure of hydrophobicity was performed to observe the contact angle of water droplets deposited on treated and untreated surfaces. The changes in contact angle were only observed in the treated samples.
- An appropriate R-R peak was successfully recorded in a dry (without conductive gel) as well as a submerged environment of the treated electrode.
- The result is the successful development of ECG electrode with the ability to function underwater for a minimum dive time of two hours, while maintaining signaling capabilities at a depth of 60 feet.

ADVANTAGES

- Reduction of DCS incidents, or at minimum, a prevention of further damage from DCS by quickened treatment.
- Low cost production of the hydrophobic electrode.
- Reduced cost of dry ECG's, since conductive gel is not needed.
- The electrode is advantageously capable of universal attachment, with an easily used snap button.
- Less "messy" and more comfortable application of electrodes to patients without conductive gel.
- Successful application in both underwater or clinic/hospital application.
- Room for development to also measure brain waves and other medical parameters in an underwater environment.

TITLE

Hydrophobic Electrocardiogram Electrodes

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