Smart Textiles Based Wireless ECG System

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Abstract

Advances in polymers, soft-electronics, biosensors and mobile communication, have led to a growing interest in wireless Electrocardiogram (ECG) monitors. A wide variety of textile-based wireless ECG sensors and systems have been developed. Typically, such wireless ECG systems rely on miniature ECG sensor/electrode that can be worn as badges, patches, or jewelry to measure and show advance reactions. Smart textile and non-contact electrodes have also been reported recently. The earlier stage of smart clothing usually tether conventional electrode sensors or devices attached to the textile. Such approaches have their limitations such as discomfort and integration with the fabric. The focus of our research is design and the development of non-contact textiles ECG electrode for remote health monitoring applications.

Introduction

Over the last few years, nanotechnology has seen an increased acceptance as well as widespread use of its applications in medicine. Smart textile has also emerged as a mature technology. The focus of our research is design and the development of non-contact textiles ECG electrode for remote health monitoring applications. Non-contact ECG electrode, developed with intelligent materials and different textile technologies, can be an integral part of telemonitoring applications . Such electrodes with integrated nanostructure conformal antenna can use a wireless transmitter to send data to any external device for remote health monitoring, telemedicine and health delivery. Here we will present the design of the integrated conformal patch antenna as well as the design for the matching circuitry for most effective signal transfer from non-contact ECG electrodes to the transmitter.

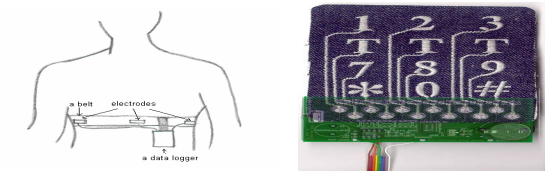

Fig 1: Textile Electrode Application

Why Ag/AgCl Electrodes

- The standard Ag/AgCl electrodes are well characterized as these electrodes have been studied for years.
- Reliability and accuracy of Ag/AgCl electrodes, and the fact that they can be easily fabricated makes it an attractive choice.
- The biggest challenge in designing a textile based smart electrode is contact impedance. Conventional Ag/AgCl electrodes use electrolyte and adhesive material between the skin and the electrode, this assure uniform signal quality.
- Cloth electrodes with multi-walled carbon tubes (MWNTs) on one side and Ag/Cl electrode on other has been proposed in the past as noncontact electrode.
- Our research is focused on development of textile based integrated (laminated, sputtered) non-contact Ag/AgCl electrode.
- Pure Silver is highly conductive.
- Silver is soft, ductile, malleable and has highest electrical and thermal conductivity in metals.
- Electrical Conductivity of Silver is around 63 x 10^6 sm^{-1}.

Material and Methods

Our Research is focused on developing an ECG electrode that does not stimulate the skin. Emphasis has been put on incorporating a wide variety of characteristic features of textiles in an effort to measure movements of the human body while simultaneously monitoring the conductivity properties of the textiles. We investigate following two methods to develop the electrodes:

Ag-sputtering electrode

- **Step 1:** Prepare the materials, such as (PU,CR,AG) for manufacturing and fabricated the Ag/AgCl textiles electrode
- **step 2:**
  - Commercially available nylon fabric is treated with Polyurethane (PU)layer .
  - PU treatment for better surface condition for metal deposition.
  - PU treatment assure uniform attachment of thin a thin metal layer on fabric substrate. T
  - 10 cm * 10 cm coated fabric will be used as electrode.

Composition	Nylon 100%
Finishing	PU lamination
Fabrics construction	Plain weave
Thickness in mm	0.117
Weight g/m*2	101
Yarn size	Warp:40 d,weft :40D
Fabrics count inch*2	126*115

Table1: Design Specifications

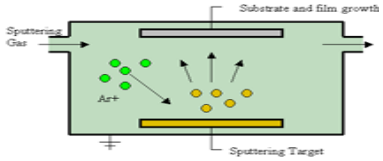

Fig 2: Sputtering Process

Development of Textile electrode by Electrolyses

Ag plated fabrics are easy to plate and machine tailored, in addition to that they have suitable characteristic, such as good conductivity and uniform electrical properties.

- **Step 1:** Same as above
- **step 2:** Ag and Pu electrodes are immersed in AgN03 electrolyte solution, as shown in the figure 2.

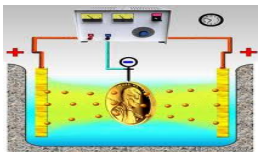

Fig 3: Electrolysis process

Conclusion

There are many advantages from use metal plated textiles such as no reaction with the skin, reusability, comfort and mobility. *we applied a polyurethane (PU) sealing so that metal plating is durable even during laundering, which clothing materials are usually subjected to.* Stretching and physical activities have minimal effect on the performance of such electrodes. Integrated with nanostructure conformal antenna, such electrodes, can used with wireless transmitter to send data to any external device for remote health monitoring, telemedicine and health delivery.