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# Bio-inspired artificial muscle based on chemical sensors

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**Abstract**

In this work, we have investigated the modeling, design and fabrication of bio-inspired artificial muscle unit capable of contracting according to the directives sent in form of chemical messengers. This new technology has the potential to revolutionize current robotics, because it could permit a paradigm shift in robots: from electro-mechanical devices to electro-chemical devices. The bio-inspired artificial muscle will be based on basic contractile units coupled to electrochemical sensors, with the purpose of allowing adaptive and flexible control similar to that in animal locomotion. An artificial nerve termination, able to modify the chemical characteristics of the inner environment, will generate directives in form of chemical messengers. Electro-chemical sensors have been used in order to detect the presence of the chemical messengers and transform them into electronic signals to be used in conventional control electronics. This study has been focused on the development and optimization of sensing materials for inorganic ions such as hydrogen ions. Among various conducting polymers studied, polyaniline (PANI) has attracted much attention due to its unique and controllable chemical and electrical properties. PANI layer has been electrochemically deposited on the gold arrays surface by cyclic voltammetry. Preliminary experiments on PANI-modified sensors in order to obtain the better sensitivity as chemical sensing used in artificial muscle unit have been carried out. To allow diffusion of chemical messages, the system has been immersed in wet environment. Using this approach, we study the effective possibility to control, assessing the performance in terms of accuracy of the control of the contraction, the impact of the delay due to the transmission time of the chemicals, precision and stability of control.


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## 1. Introduction

The current state of the art on actuation technology is mainly based on hydraulic/pneumatic and electromagnetic technology. Several improvements have been introduced since the first prototypes, and current commercial actuators have achieved a notable degree of refinement. However, current robots are electro-mechanical devices that are hard-bodied, usually heavy, bulky and complex. The main objective of this study is to concept-prove the feasibility of using electro-chemical processes in order to activate electrically responsive bio-inspired actuators based on *functional materials* (such as Shape Memory Alloys and Electro Active Polymers) [1,2]. In this way, functional materials will entirely performed the overall chain that combines chemical sensing with modulation of actuation. In this work, we report the study, design and fabrication of sensors to apply in bio-inspired artificial muscle unit capable of contracting according to the directives sent in form of chemical messengers. In particular, PANI-modified sensors have been used as sensing platform for hydrogen ions determination in a wet environment.

## 2. Experimental part

The electrochemical screen-printed cell has been inserted into homemade flow-cell. Polymerization of aniline monomer has been obtained on the surface of gold screen-printed electrode starting from a 2.5 mM solution of aniline prepared in $HClO_4$ 50 mM. The response of the polyaniline (PANI)-modified sensors at various hydrogen ions concentrations has been evaluated by means Open Circuit Potential (OCP) measurements. An agarose gel has been deposited on the sensor surface in order to mimic biological wet environment. A linear increase of OCP has been observed in relation of increase of hydrogen ions concentration. Experiments on PANI-modified sensors in order to achieve the better sensitivity as chemical sensing have been carried out (Fig. 1).

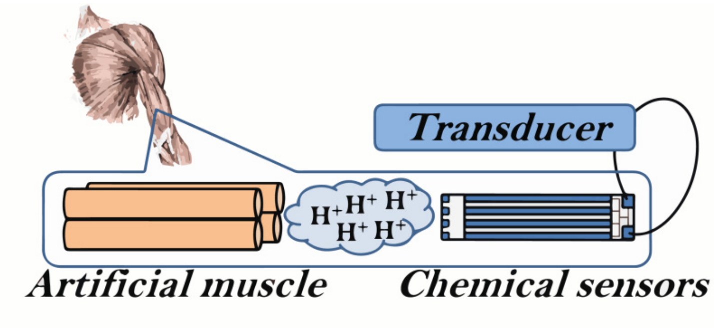


Fig. 1. Proof of concept of bio-inspired muscle.

## 3. Conclusions

In this study, preliminary studies on using electro-chemical processes in order to activate electrically responsive bio-inspired actuators have been realized.

## References

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