Compliant Lightweight Non-Invasive Standalone Marine Sensor Tagging System

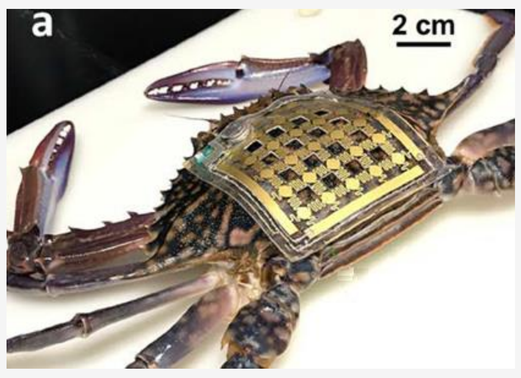
جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

JOHANNA NASSAR, SOHAIL F. SHAIKH, HAROLD F. MAZO-MANTILLA, MUHAMMAD M. HUSSAIN

mmh Labs, Computer Electrical Mathematical Science and Engineering Division,

King Abdullah University of Science and Technology (KAUST), Thuwal 23955-6900, Saudi Arabia.

INTRODUCTION

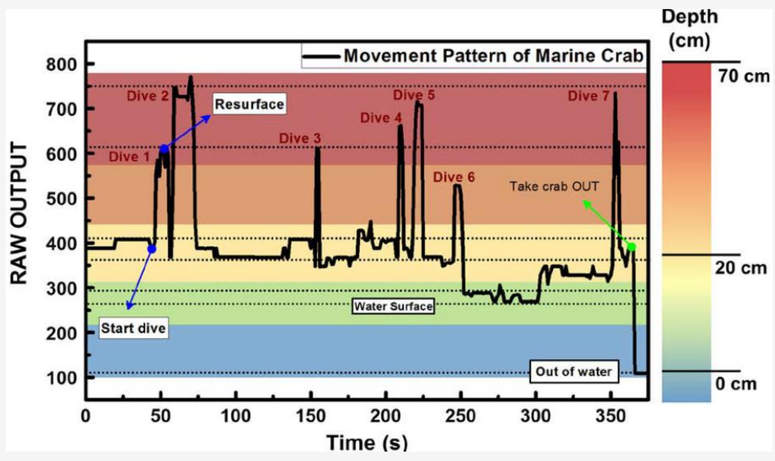


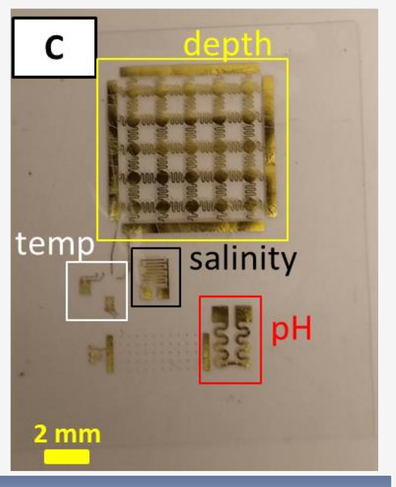
Recent research activities on marine species are carried out based on studies on their habitat and behavioural patterns. These technologies are used mainly for measuring the marine environment by monitoring control parameters like temperature, pressure, salinity, pH and others.

However, available solutions are bulky, heavy, and expensive, in addition, they inconveniences to the marine species on which they are attached using clamps. To tackle this problem, one of the solution is to use sensors on marine species. This can reduce the cost and the complexity of the analysis systems without losing any precision on the acquired data. The sensors needed for such application must be flexible, light-weight, non-invasive, biocompatible, and suitable for the underwater environment. Thus, there will not be any inconvenience to the species and no obvious behavioral change due to deployment.

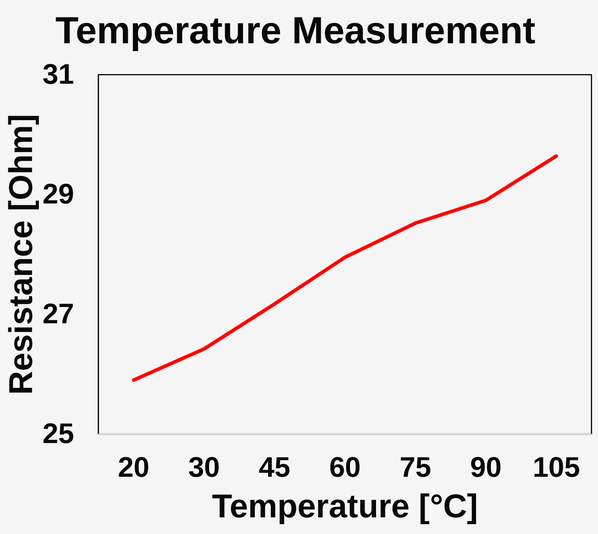
OBJECTIVES

- Virtual reproduction the marine environment
- Carry out a non-invasive attachment system to use on animals
- Develop a stretchable and flexible sensor
- Reduce sensor size and weight to decrease the impact on the animal
- Measurements of 4 variables: Depth, temperature, salinity and pH

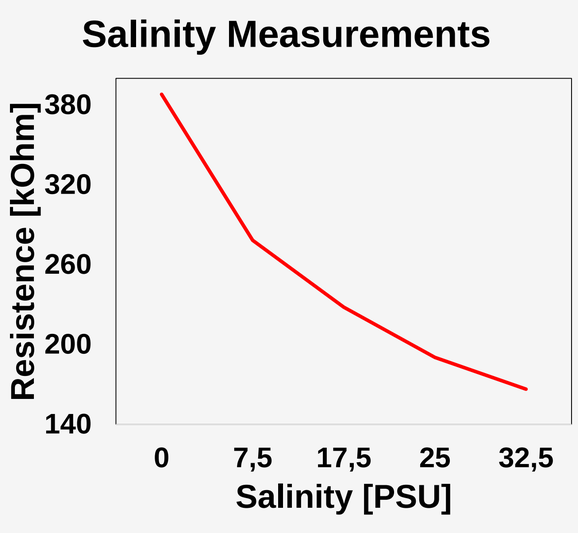




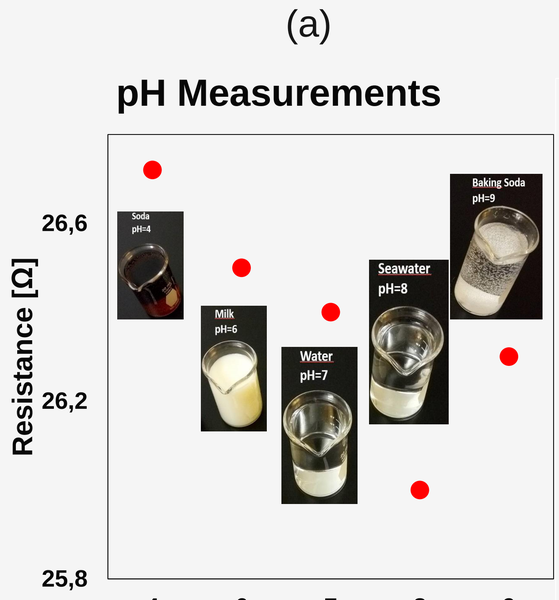
LABORATORY TESTS



(a)



(b)



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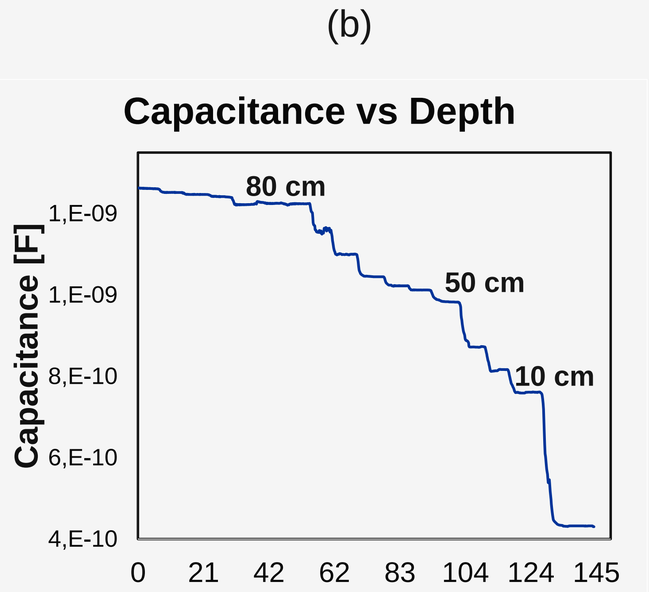
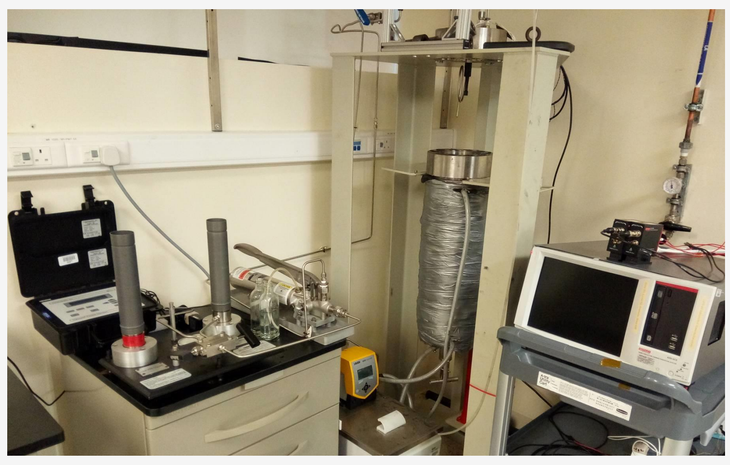
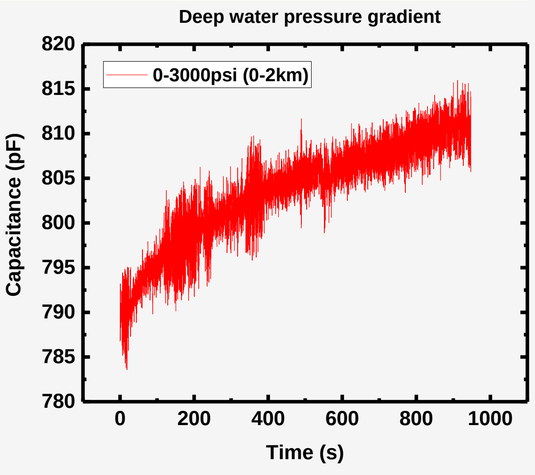


(d)

Laboratory tests: (a) Resistance vs Temperature for Gold; (b) Copper pattern resistance vs Water salinity; (c) Resistance of Copper pattern covered with Graphene vs pH; (d) Sensor capacitance vs Sensor Depth.

RESULTS





High Depth simulation test.

The tests that were carried out allowed to characterize the sensor sensitivity range for each measurement. For the temperature (test range [20,105] °C), it was found that platinum (habitual used material to measure temperature) has a higher sensitivity than gold, although gold has a higher accuracy.

The salinity measurement test was made on the designed salinity patterns. It was performed by testing the salinity range [0,40] PSU, where the typical sea salinity oscillates between 30 and 38 PSU. The tests showed that copper has a higher sensitivity to the salinity changes than gold, but gold presents a higher accuracy than copper.

The performing of the pH tests were made by using 5 pH known value samples (soda, milk, pure water, seawater and baking soda), mince, pH values from 4 to 9, measuring increasing and decreasing pH ways. Additionally, a graphene layer set on a pattern similar to the salinity pattern, to increase the conductivity measurement capacitance of the pattern. The results showed that copper is higher sensible to pH changes than gold, and a higher measurement range on copper than on gold as well.

Sensor attatchment on diverse marine animals.

CONCLUSIONS

- The current sensor design allows to analyze the sea bottom environment by putting it on a sea animal. The effect of these actions is lower (and null) than any other existing marine environment analysis sensor.
- This sensor allows to measure a temperature up to 105 °C without risking any of its components. It also has a favorable response to the variation of pH from acid to base. The salinity range measured by this sensor is useful for the sea salinity (between 32 and 28 PSU).
- The endurable pressure for the sensor allows it to go beyond the 2 km depth, which is useful to continue studying the high depth sea.

BIBLIOGRAPHY

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[2] J. M. Nassar, S. M. Khan, S. J. Velling, A. Diaz-Gaxiola, S. F. Shaikh, N. R. Geraldi, G. A. Torres Sevilla, C. M. Duarte, M. M. Hussain*, "Compliant Lightweight Non-Invasive Standalone “Marine Skin” Tagging System", *npj Flex. Elect.* 2, Article number: 13(2018), doi:10.1038/s41528-018-0025-1