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An approach to the application of additive manufacturing for water environments: A case study to measure dissolved carbon dioxide

Iván Ibáñez-Felip, Rosario Vidal

Department of Mechanical Engineering and Construction, GID, Universitat Jaume I, Av. Sos Baynat s/n, Castelló 12071, Spain

** Corresponding author: felipi@uji.es*

***Abstract* – This paper describes the design of a case for the grouping and protection of the elements required for the quantification of dissolved carbon dioxide, allowing measurements to a depth of 10 meters. The possibility of implementing additive manufacturing (AM) technologies to reduce the production cost and design capabilities of the system is studied.**

***Keywords* -** *Additive manufacturing, Product design, Carbon dioxide, Low-cost, Dissolved*

I. INTRODUCTION

To understand the variability of carbon dioxide concentrations in different terrestrial systems, field measurements are necessary and require high quality equipment which must be used in large quantities and over long periods of time. However, the existing products on the market are excessively expensive.

This situation has led to the proliferation of projects for the adaptation and implementation of Non-dispersive Infrared sensor (NDIR) technology [1,2,3]. NDIR sensors offer good performance at low cost and minimal maintenance and infrastructure requirements [4,5]. By contrast, there are few case studies with the purpose of forming a container/enclosure that protects the different electronic equipment from the aqueous environment, being mainly studied in this field the surface measurement equipment [3,6,7].

This work focuses on the creation of a housing for the grouping of the elements necessary for the quantification of carbon dioxide dissolved in water, allowing measurements to be taken at a depth of 10 meters. The ability to implement additive manufacturing technologies in order to reduce the production cost of devices is also studied.

II. THE APPLICATION OF ADDITIVE MANUFACTURING

Two additive manufacturing techniques were studied, Fused Deposition Modeling (FDM) and Stereolithography (SLA) for their technical capabilities and market presence. Thus, two prototypes of similar shape and purpose were manufactured with both techniques. PET-G was used for FDM while ELEGOO ABS-like photopolymer resin was used for SLA. The different casings were immersed in water to a depth of 5 meters to observe the particularities of the technique and possible complexities, Figure 1.

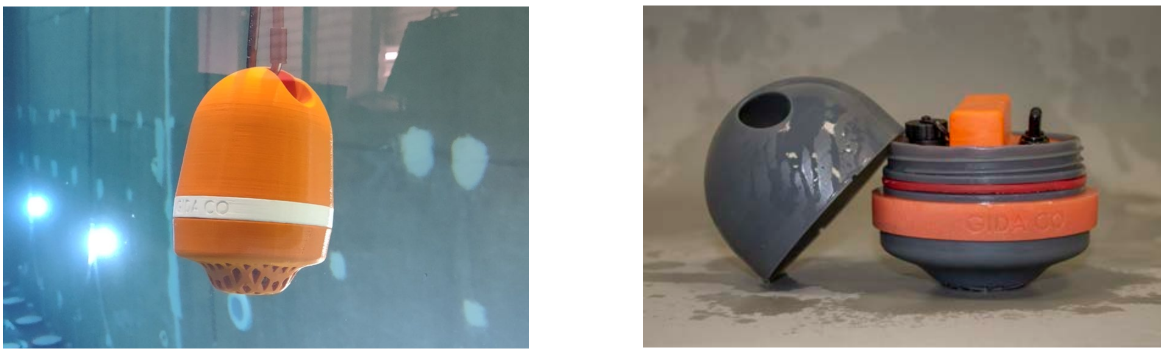

Fig 1. A: FDM prototype immersed in water. B: SLA prototype open.

III. RESULTS

Limitations of the FDM technique due to the presence of defects/holes in parts resulted in low watertightness, although, surface finishes of two coats of polyester resin were applied by brush.

On the other hand, SLA offers better performance together with the use of surface finishes, making it possible to obtain watertight housings. However, the use of photopolymer resin presents problems of embrittlement and deformation when exposed to prolonged periods of time, these facts should be studied in greater depth.

IV. CONCLUSIONS

Through the different prototypes it has been possible to conclude the capabilities and methods for the use of additive manufacturing in the conformation of parts/devices for aqueous environments. Likewise, a functional prototype of a probe for the measurement of dissolved carbon dioxide case to measure dissolved carbon dioxide has been generated, which can be used in future research.

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