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BIOMIMETIC ELECTROAERODYNAMIC PROPULSION: SUSTAINABLE ADVANCEMENTS FOR SILENT AIRCRAFT

Abstract

Electroaerodynamic (EAD) propulsion, first proposed in 1911, has gained renewed interest due to recent technological advancements in the disciplines of battery technology and rapid prototyping. (ex. NASA's Electrified Aircraft Propulsion (EAP) research). This study investigates biomimetic EAD electrodes inspired by ocean sponges, aligning with the IAC 2025 theme "Sustainable Space: Resilient Earth" by exploring eco-friendly propulsion alternatives. EAD is a key technology for the future of near-silent propulsion and investigating a biomimetic structure of the electrodes can prove to bear significant benefits for all other types of propulsion in the future (for example electrospray propulsion for small satellites). The biomimetic inspiration is taken from ocean sponges which have a high efficiency in pumping water that can be replicated in the design. We compare three manufacturing methods: Fused Deposition Modelling (FDM), metal additive manufacturing, and metal machining, emphasizing sustainable production techniques. Performance is evaluated using anemometric measurements, focusing on thrust-to-power ratios and thrust densities that are calculated from the data. For FDM prints electroplating is employed as a way to make them conductive and reduce the mass of a segment by adding just a thin layer of metal of approximately 0.03 mm. Metal additive manufacturing is done in cooperation with Nordic Waves company in Hjorthagen, Stockholm County. This technology allows for very detailed manufacturing of complex biomimetic shapes with precision down to 0.2 mm. Various electrode geometries are examined across manufacturing types, with results indicating performance variations based on both geometry and manufacturing method. All electrode pairs have the same diameter of 3 cm, and a constant volume of 349 mm2 and are powered with the same range of voltage so they can be directly compared. These findings have significant implications for optimizing EAD propulsion systems, potentially revolutionizing silent aircraft and drone technology. This research contributes to sustainable space activities and Earth-based applications, addressing key areas of the IAC 2025 theme. By advancing silent propulsion technology, we aim to reduce noise pollution and environmental impact, fostering a more resilient Earth through innovative space-inspired solutions.