World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:11, No:10, 2017

Development of Anti-Fouling Surface Features Bioinspired by the Patterned Micro-Textures of the Scophthalmus rhombus (Brill)

Authors : Ivan Maguire, Alan Barrett, Alex Forte, Sandra Kwiatkowska, Rohit Mishra, Jens Ducrèe, Fiona Regan

Abstract : Biofouling is defined as the gradual accumulation of Biomimetics refers to the use and imitation of principles copied from nature. Biomimetics has found interest across many commercial disciplines. Among many biological objects and their functions, aquatic animals deserve a special attention due to their antimicrobial capabilities resulting from chemical composition, surface topography or other behavioural defences, which can be used as an inspiration for antifouling technology. Marine biofouling has detrimental effects on seagoing vessels, both commercial and leisure, as well as on oceanographic sensors, offshore drilling rigs, and aquaculture installations. Sensor optics, membranes, housings and platforms can become fouled leading to problems with sensor performance and data integrity. While many anti-fouling solutions are currently being investigated as a cost-cutting measure, biofouling settlement may also be prevented by creating a surface that does not satisfy the settlement conditions. Brill (Scophthalmus rhombus) is a small flatfish occurring in marine waters of Mediterranean as well as Norway and Iceland. It inhabits sandy and muddy coastal waters from 5 to 80 meters. Its skin colour changes depending on environment, but generally is brownish with light and dark freckles, with creamy underside. Brill is oval in shape and its flesh is white. The aim of this study is to translate the unique micro-topography of the brill scale, to design marine inspired biomimetic surface coating and test it against a typical fouling organism. Following extensive study of scale topography of the brill fish (Scophthalmus rhombus) and the settlement behaviour of the diatom species Psammodictyon sp. via SEM, two state-of-the-art antifouling surface solutions were designed and investigated; A brill fish scale bioinspired surface pattern platform (BFD), and generic and uniformly-arrayed, circular micropillar platform (MPD), with offsets based on diatom species settlement behaviour. The BFD approach consists of different ~5 µm by ~90 µm Brill-replica patterns, grown to a 5 µm height, in a linear array pattern. The MPD approach utilises hexagonal-packed cylindrical pillars 10.6 µm in diameter, grown to a height of 5 µm, with vertical offset of 15 µm and horizontal offset of 26.6 µm. Photolithography was employed for microstructure growth, with a polydimethylsiloxane (PDMS) chip-based used as a testbed for diatom adhesion on both platforms. Settlement and adhesion tests were performed using this PDMS microfluidic chip through subjugation to centrifugal force via an in-house developed ‘spin-stand’ which features a motor, in combination with a high-resolution camera, for real-time observing diatom release from PDMS material. Diatom adhesion strength can therefore be determined based on the centrifugal force generated at varying rotational speeds. It is hoped that both the replica and bio-inspired solutions will give comparable anti-fouling results to these synthetic surfaces, whilst also assisting in determining whether anti-fouling solutions should predominantly be investigating either fully bioreplica-based, or a bioinspired, synthetically-based design.

Keywords : anti-fouling applications, bio-inspired microstructures, centrifugal microfluidics, surface modification
Conference Title : ICSAM 2017 : International Conference on Sensors, Actuators and Microsystems
Conference Location : Barcelona, Spain
Conference Dates : October 30-31, 2017