being selectively arranged on the substrate to at least partially decrease biofouling when exposed to an aquatic environment compared to a substrate without said patterned surface, wherein the first structure type has a base diameter in the range of 0.05 μm to 50 μm and an aspect ratio in the range of 1 to 100 and the second structure type has a base diameter in the range of 50 μm to 350 μm and an aspect ratio in the range of 0.05 to 4.

Advantageously, the substrate may comprise a patterned surface comprising a bio-mimetic pattern. The bio-mimetic pattern may be inspired by naturally occurring patterns found on the surfaces of various decapods. Further advantageously, the patterned surface on the substrate may be inspired by decapods that naturally exhibit low levels or absence of biofouling in heavy fouling conditions. Advantageously, these decapods may not exhibit burrowing behaviour which may result in decreased fouling of their surface. Therefore, the low levels or absence of biofouling may be inherent to the properties of their outer surface. Advantageously, the patterned surface may comprise a bio-mimetic pattern inspired by the microtopography on the surface, in particular the carapace, of decapods such as *Myomenippe hardwickii*, *Gaillardiellus orientalis* or *Acanthodromia margarita*. Advantageously, these decapods may show low levels or absence of biofouling despite their occurrence in heavy fouling environments and their lack of burrowing behaviour.

Advantageously, the patterned surface may comprise protruding structures of various shapes and sizes that may prevent the settlement of aquatic organisms. That is, the substrate comprising the patterned surface may possess antifouling properties. Further advantageously, the substrate may comprise protruding structures of various shapes and sizes

that may reduce the strength of adhesion of aquatic organisms and/or biofilms on surfaces. That is, substrate may have fouling-release properties.

extending from the surface of the substrate, said structures being comprised of a first structure type and a second structure type that has different dimensions to the first structure type, the structures being selectively arranged on the substrate to at least partially decrease biofouling when exposed to an aquatic environment compared to a substrate without said patterned surface, wherein the first structure type has a base diameter in the range of 0.05 μm to 50 μm and an aspect ratio in the range of 1 to 100 and the second structure type has a base diameter in the range of 50 μm to 350 μm and an aspect ratio in the range of 0.05 to 4.

Advantageously, the substrate may prevent biofouling on surfaces regardless of how it is formed. Advantageously, the patterned surface may be formed directly on the surface of the substrate by imprinting the structures thereon or by applying liquid medium comprising particles capable of self-arrangement on a surface. That is, the particles may spontaneously form 3-dimensional structures based on a 2-dimensional design. Advantageously, the patterned surface may prevent antifouling regardless of the material of the substrate. Advantageously, the substrate may be any material that may be used in an aquatic environment.

Further advantageously, patterned substrate may facilitate the fabrication of a mechanically stable protective surface (antifouling and/or foul-release) that is durable and is not susceptible to corrosion in an aquatic environment. Advantageously, the patterned substrate comprising the patterned surface may be permanent, allowing the preventative effect of biofouling to last longer. More advantageously, the substrate may have minimum effect on the performance of underwater equipment and aquatic vessels.

Further advantageously, the patterned substrate may facilitate the fabrication of a protective surface (antifouling/foul-release) that is non-toxic and does not adversely affect the organisms that are present in the aquatic

environment in which it is used. In particular, the patterned substrate may circumvent the use of biocides such as tributylin (TBT) that are toxic to aquatic organisms.

In a third aspect, there is provided a method for fabricating a substrate comprising a patterned surface to at least partially decrease biofouling in aquatic environments, the method comprising the steps of: (a) providing protruding structures, the protruding structures comprising of a first structure type and a second structure type that has different dimensions to the first structure type on the substrate; and (b) selectively arranging the protruding structures on the substrate, wherein the first structure type has a base diameter in the range of 0.05 μm to 50 μm and an aspect ratio in the range of 1 to 100 and the second structure type has a base diameter in the range of 50 μm to 350 μm and an aspect ratio in the range of 0.05 to 4.

Definitions

The following words and terms used herein shall have the meaning indicated:

The term "aquatic environment" refers to any environment in a body of water including fresh water, salt water, buffer, or any mixture thereof. The body of water may be of natural or artificial composition.

The term "bio-mimicry" refers to the design and production of materials, structures, and systems that are modelled on biological entities and processes. The terms "bio-mimicking" and "bio-mimetic" should be construed accordingly.

The term "biofouling" refers to the accumulation of microorganisms, plants, algae, animals or any mixture thereof,

on wetted surfaces and adsorption of substances such as proteins and polymers that are excreted by these organisms on the wetted surfaces.

The term "base diameter", with reference to structures of a circular or spherical shape, refers to the diameter or

Claims

1. A substrate for aquatic environments, the substrate having a patterned surface comprising a plurality of protruding structures extending from the surface of the substrate, said structures being comprised of a first structure type and a second structure type that has different dimensions to the first structure type, the structures being selectively arranged on the substrate to at least partially decrease biofouling when exposed to an aquatic environment compared to a substrate without said patterned surface, wherein the first structure type has a base diameter in the range of 0.05 μm to 50 μm and an aspect ratio in the range of 1 to 100 and the second structure type has a base diameter in the range of 50 μm to 350 μm and an aspect ratio in the range of 0.05 to 4.

2. The substrate according to claim 1, further comprising N different structure types that have different dimensions to the first structure type, the second structure type or each other, wherein N is any integer.

3. The substrate according to claim 2, wherein N is 1.

4. The substrate according to any one of the preceding claims, wherein the structures are arranged on the surface in an interspersed manner.

5. The substrate according to claim 4, wherein the structures of the first structure type are adjacent to structures of the second structure type.

6. The substrate according to any one of the preceding claims, wherein the different structure types are independently arranged in a general array shape selected from the group consisting of hexagonal array, square array and combinations thereof.

7. The substrate according to any one of the preceding claims, wherein the different structure types are at least partially overlaid with each other.

8. The substrate according to any one of the preceding claims, wherein the different structure types are independently arranged in grouped clusters on said substrate.

9. The substrate according to claim 8, wherein the grouped clusters are independently arranged in a general array shape selected from the group consisting of hexagonal array, square array and combinations thereof.

10. The substrate according to any of the preceding claims, wherein each structure type has a shape that is independently selected from the group consisting of a cylinder, cone, prism, pyramid and hemisphere.

11. The substrate according to any one of the preceding claims, wherein ~~the first structure type has at least one of the following features:~~

~~(a) a base diameter in the range of 0.05 µm to 150 µm;~~

~~(b) an aspect ratio in the range of 0.5 to 150; or~~

~~(c)~~ athe distance between each structure of the first structure type is in the range of 0.1 µm to 500 µm.

12. The substrate according to any one of claims 1 to 10, wherein ~~the second structure type has at least one of the following features:~~

~~(a) a base diameter in the range of 5 µm to 350 µm;~~

~~(b) an aspect ratio in the range of 0.05 to 150 or~~

~~(c) a~~the distance between each structure of the second structure type is in the range of 0.5 μm to 1500 μm.

13. The substrate according to any one of claims 2 to 10, wherein the N different structure types have at least one of the following features:

(a) a base diameter in the range of 10 μm to 750 μm; or

(b) an aspect ratio in the range of 0.05 to 10.

14. The substrate according to any of the preceding claims, wherein at least one of:

(a) the distance between each cluster of the first structure type;

(b) the distance between each cluster of the second structure type; or

(c) the distance between each cluster of the third structure type;

is in the range of 0.5 μm to 1500 μm.

15. The substrate according to any of the preceding claims, wherein the substrate is a polymer or copolymer, optionally selected from the group consisting of polydimethylsiloxane, polyurethane, polymethylmethacrylate and any mixture thereof.

16. The substrate according to any of the preceding claims, further comprising a polymeric surface coating.

17. A use of a substrate for aquatic environments, the substrate having a patterned surface comprising a plurality of protruding structures extending from the surface of the substrate, said structures being comprised of a first structure

type and a second structure type that has different dimensions to the first structure type, the structures being selectively arranged on the substrate to at least partially decrease biofouling when exposed to an aquatic environment compared to a substrate without said patterned surface, wherein the first structure type has a base diameter in the range of 0.05 μm to 50 μm and an aspect ratio in the range of 1 to 100 and the second structure type has a base diameter in the range of 50 μm to 350 μm and an aspect ratio in the range of 0.05 to 4.

18. A method for fabricating a substrate comprising a patterned surface to at least partially decrease biofouling in aquatic environments, the method comprising the steps of:

(a) providing protruding structures, the protruding structures comprising of a first structure type and a second structure type that has different dimensions to the first structure type on the substrate, wherein the first structure type has a base diameter in the range of 0.05 μm to 50 μm and an aspect ratio in the range of 1 to 100 and the second structure type has a base diameter in the range of 50 μm to 350 μm and an aspect ratio in the range of 0.05 to 4; and

(b) selectively arranging the protruding structures on the substrate.

19. The method according to claim 18, wherein the providing step further comprises the steps of:

(i) providing an image of a crustacean surface;

(ii) determining the dimensions of the structures on the crustacean surface from the image of (i);

(iii) constructing histograms of the dimensions of the structures on the crustacean surface determined in (ii);

(iv) extracting the most common dimensions of the structures on the crustacean surface from the histograms of (iii);

(v) approximating a pattern based on the dimensions extracted in (iv); and

(vi) fabricating the protruding structures in the pattern of (v).