

IIT Guwahati uses aloe vera to remove oil from water

Using the membrane, the researchers were able to separate both light (kerosene) and heavy oil from water even under harsh conditions

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Researchers have for the first time used a naturally occurring material – aloe vera gel – which inherently has superior oil repelling (oleophobic) property to separate oil from water. So far researchers have only been mimicking the structure of naturally existing materials such as fish scales to achieve super oleophobicity. While conventionally the topography and chemistry of materials had to be optimised to make them repel oil extremely, the use of aloe vera gel-based coating modified with some molecules was sufficient to make the surface of substrates extremely oil repelling.

Aloe leaves

The team led by Dr. Uttam Manna from the Department of Chemistry at Indian Institute of Technology (IIT) Guwahati used the thick gel contained in the leaves of aloe vera plant to convert a commercially available porous material that is oil-loving (oleophilic) to become extremely oil-repelling by



We were able to use the aloe vera gel-coated membrane at least 25 times to separate oil from water, and the efficiency of separation remained above 97%, says Uttam Manna (centre).

coating it with the gel.

Like a drop of water that nearly retains its spherical shape when placed on a lotus leaf, the commercially available material coated with the gel exhibited high oil

contact angle of about 150 degrees under water. The greater the oleophobic nature of a surface the higher will be the contact angle and more spherical will be the shape of the oil droplet.

The researchers found the gel by itself had superior oleophobicity with contact angle of 156 degree. Even when subjected to extreme conditions such as exposure to boiling (100 degree C) water for 60 minutes and liquid nitrogen (-196 degree C) for 24 hours the oleophobic nature of the gel was not compromised. Similarly, the oleophobicity of the gel remained intact when exposed to various chemically harsh conditions such as very acidic (pH 1) and highly alkaline (pH 12) medium, artificial sea water and river water for 30 days.

Super-oleophobic

"We were surprised seeing the gel exhibit super-oleophobicity. But even more surprising was that the gel retained super-oleophobicity even after we exposed it to several harsh conditions," says Arpita Shome from IIT Guwahati and first author of a paper published in the *Journal of Materials Chemistry A*.

The researchers used the gel to coat a commercially available porous material that is inherently

oleophilic (oil-loving). Once coated, the material became extremely oil-repelling with contact angle of 151 degrees. The super-oleophobicity remained intact even when exposed to severe chemical conditions (highly acidic and alkaline water, artificial sea water and river water) but reduced a bit (146 degrees) when subjected to bending and twisting. But the oleophobicity reduced drastically to less than 100 degrees under severe physical abrasions such as sand paper abrasion, knife scratching test etc.

The team directed its efforts to make the surface exhibit super-oleophobicity even after extreme physical abuse. For that they used a small molecule (dipentaerythritol pentaacrylate or 5Acl) to bind to the coated gel. "About 99% of the gel is made of water, and amino acids and enzymes among other things make up the remaining 1%. The amino acids and enzymes provide amine group which helps in binding (cross linkage) with the small molecule," says Dr. Manna.

Post binding with the small mo-

lecule, the oleophobicity reduced to 138 degrees. "We increased the oleophobicity to 155 degrees by adding glucamine, which is hydrophilic, to the coating," Dr. Manna says. The oil-repelling nature remained intact even when the material was stretched by 150% and bent for about 1,000 times.

Being porous and stretchable, the coated material acts a membrane to separate oil and water. Since it is super-oleophobic (and therefore highly water-loving), the membrane allows water to pass through it thus helping in separating oil from water.

The researchers were able to separate both light (kerosene) and heavy oil from water using the membrane. "We were able to use the membrane repeatedly for at least 25 times to separate oil from water and the efficiency of separation remained above 97%," Dr. Manna says. The membrane retained its efficiency to separate oil and water even under harsh conditions of extreme pH, high salinity, and low and high temperatures.