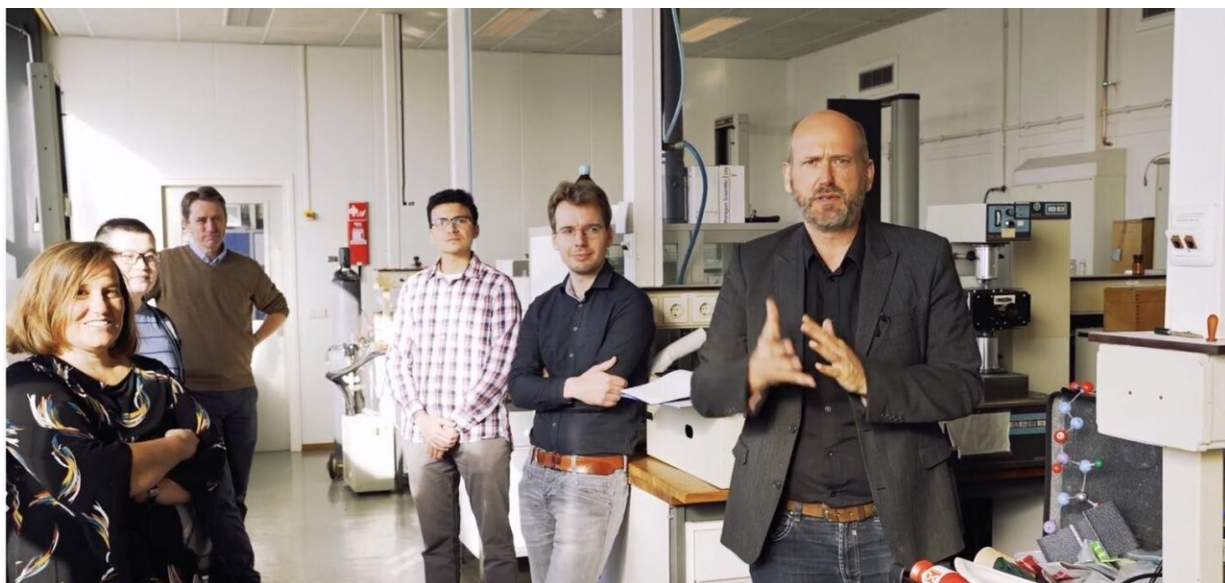


Recyclable bioplastic membrane to clear oil spills from water

March 9 2021



The hybrid research group combining staff from a research university (University of Groningen) and an applied university (NHL Stenden). Members are (left to right) Katja Loos, Chongnan Ye, Rik Brouwer, Renato Lemos Cosse, Vincent Voet and Rudy Folkersma. Credit: University of Groningen / Chemport Europe

Polymer scientists from the University of Groningen and NHL Stenden University of Applied Sciences, both in the Netherlands, have developed a polymer membrane from biobased malic acid. It is a superamphiphilic vitrimer epoxy resin membrane that can be used to separate water and

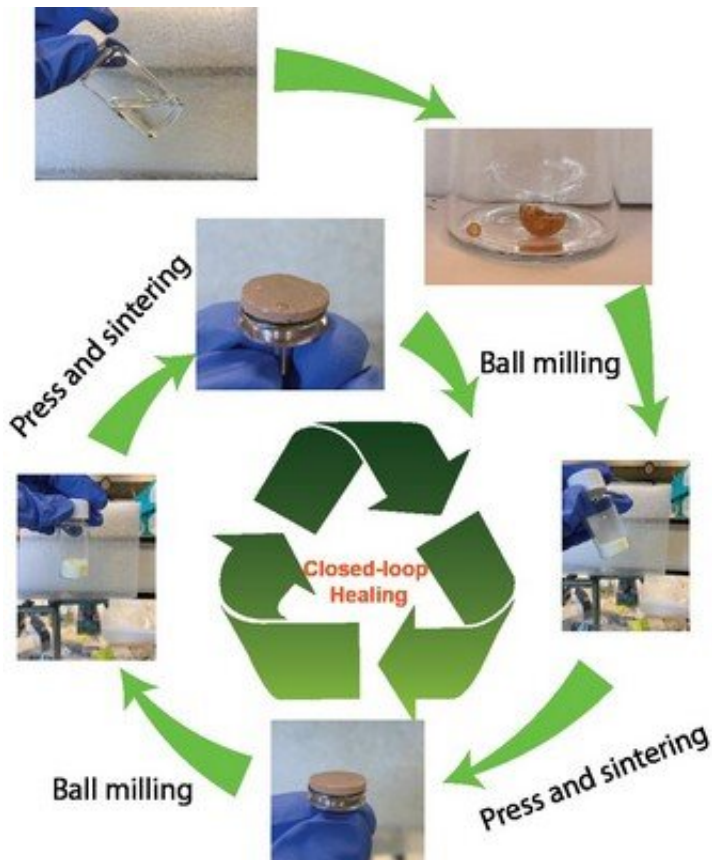
oil. This membrane is fully recyclable. When the pores are blocked by foulants, it can be depolymerized, cleaned and subsequently pressed into a new membrane. A paper describing the creation of this membrane was published in the journal *Advanced Materials* on March 7, 2021.

How do you clean up an oil spill in [water](#)? This is quite a challenge. Superamphiphilic membranes, that "love" both oil and water, are a promising solution but not yet a very practical one. These membranes are often not robust enough for use outside the laboratory environment and the [membrane](#) pores can clog up as a result of fouling by algae and sand. Chongnan Ye and Katja Loos from the University of Groningen and Vincent Voet and Rudy Folkersma from NHL Stenden used a relatively new type of [polymer](#) to create a membrane that is both strong and easy to recycle.

Dynamic network

In recent years, the researchers from both institutes have joined forces to investigate vitrimer plastics, polymer materials that have the mechanical properties and chemical resistance of a thermoset plastic. However, vitrimer plastics can also behave like a thermoplastic, since they can be depolymerized and reused. This means that a vitrimer plastic has all the qualities to make a good membrane for oil spill remediation.

"Furthermore, it was made from malic acid, a natural monomer," adds Loos.



The new vitrimer membrane is made by pressing and sintering of polymers from the natural monomer malic acid. This membrane can be recycled by ball milling and subsequent pressing and sintering. Credit: Chongnan Ye, University of Groningen

"The polymers in the vitrimer are crosslinked in a reversible manner," explains Voet. "They form a dynamic network, which enables recycling of the membrane." The vitrimer is produced through base-catalyzed ring-opening polymerization between pristine and epoxy-modified biobased malic acid. The polymers are ground into a powder by ball milling and turned into a porous membrane through the process of sintering.

Both water and oil will spread out on the resulting superamphiphilic membrane. In an oil spill, much more water is present than oil, which

means that the membrane is covered by water that can then pass through the pores. Voet: "The water film on the membrane's surface keeps the oil out of the pores so that it is separated from the water."

The membrane is firm enough to filter oil from the water. When sand and algae clog up the pores, the membrane can be depolymerized and recreated from the [building blocks](#) after removal of the pollutants. "We have tested this on a laboratory scale of a few square centimeters," says Loos. "And we are confident that our methods are scalable, both for the polymer synthesis and for the production and recycling of the membrane." The scientists are hoping that an industrial partner will take up further development.

Creating this new membrane for oil spill remediation shows the power of cooperation between a research university and an applied university. "A while ago, we decided that the polymer groups at the two institutes should become one, by sharing students, staff and facilities. We recently started the first hybrid research group in the Netherlands," explains Loos. This makes it easier to find applications for newly designed materials. Voet adds, "Polymer chemists strive to link molecular structures to material properties and applications. Our hybrid research team has the experience to do just that."

More information: Chongnan Ye et al, Robust Superamphiphilic Membrane with a Closed-Loop Life Cycle, *Advanced Materials* (2021). [DOI: 10.1002/adma.202008460](https://doi.org/10.1002/adma.202008460)

Provided by University of Groningen

Citation: Recyclable bioplastic membrane to clear oil spills from water (2021, March 9) retrieved 11 May 2024 from <https://phys.org/news/2021-03-recyclable-bioplastic-membrane-oil.html>

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