Technology Offer

Superamphiphobic membranes for gas exchange and scrubbing

Ref.-No.: 0903-4616-LC

Novel gas exchange membranes based on superamphiphobic coatings applied on metal meshes were created and tested in different applications, like gas scrubbing and blood oxygenation.

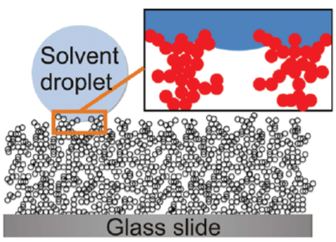
By using the novel membrans drawbacks of traditional membranes - like insufficient wetting, plugging and depositions chemical incompatibility and temperature instability - can be avoided.

Background

Porous polymer membranes are also used in various gas scrubbing applications. For example, acidic gases such as CO_2, SO_2 and H_2S are extracted from process and waste gases by contacting these gases via a gas-permeable membrane with a liquid medium such as an aqueous solution of amines which is capable to absorb the acidic gases.
The gas-exchange capacity of these membranes tends to be impaired by the insufficient chemical long-term resistance of most of the polymeric membranes commercially available and also by a gradual wetting of the membranes which increases the resistance to mass transfer and may decrease the process efficiency dramatically.

Another important application of polymer membranes is the process of blood oxygenation in heart-lung machines. Unfortunately, all synthetic materials display a more or less pronounced incompatibilty with blood. Contact with the artificial surface can induce hemolysis, protein denaturation and platelet and leukocyte damage and thrombosis. The resulting deposition of fibrin or platelets on the surface of the membrane greatly reduces the gas exchange rate.

Easy-to-fabricate oil- and water-repellent superamphiphobic coatings are made from soot encased in a silica shell [1]. The coating is sufficiently oil-repellent to cause the rebound of impacting drops of hexadecane. The coating is transparent and can be applied to a variety of heat-resistant surfaces, such as aluminum, copper, or stainless steel.



Liquid	Surface tension (mN/m)	Superamphiphobic surface SCA°	Roll-off angle°
Water	72.1	165 ± 1	1 ± 1
Diiodomethane	50.9	161 ± 1	2 ± 1
Ethylene glycol	47.3	160 ± 1	2 ± 1
Peanut oil	34.5	158 ± 1	4 ± 1
Olive oil	32.0	157 ± 1	4 ± 1
Hexadecane	27.5	156 ± 1	5 ± 1
Tetradecane	26.5	154 ± 1	5 ± 1

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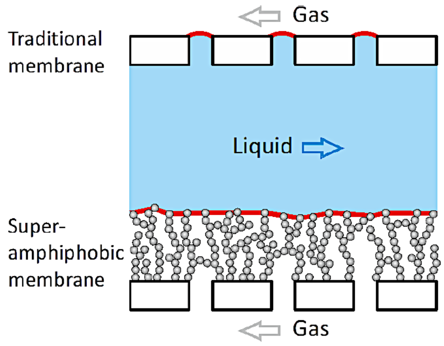
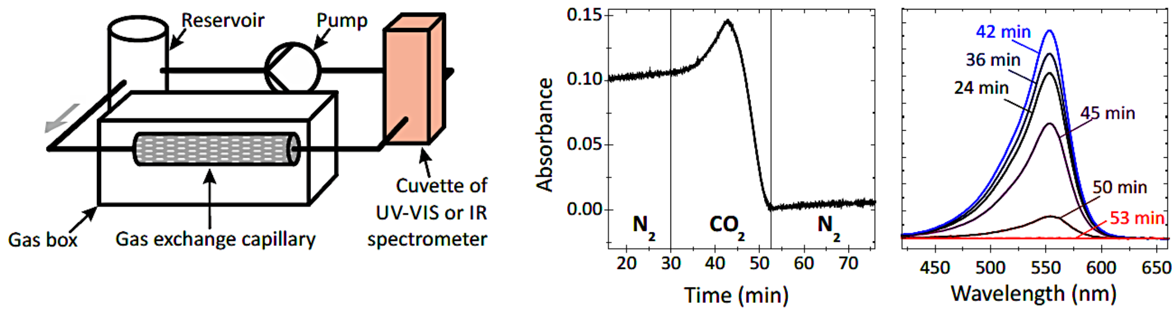


Possible applications of the novel membranes:

- gas scrubbing (e.g. SO_2, SO_3 and H_2S, HCl, HCN, $TiCl_4$, TEOS etc.)
- CO_2 amine wash
- gas drying

Example:

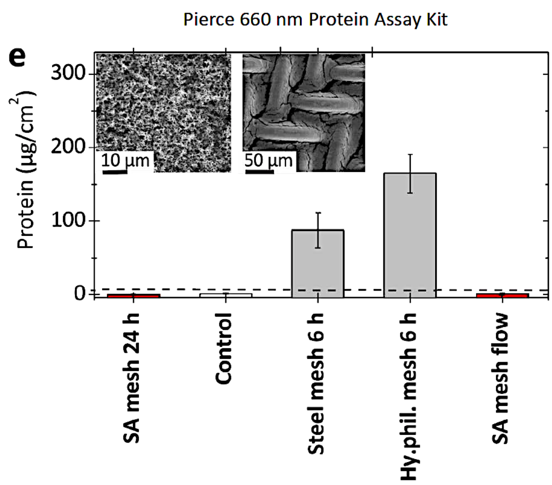
Neutralization of $NaOH_{(aq)}$ $CO_2 + 2\,H_2O \rightleftharpoons HCO_3^- + H_3O^+$ Phenolphthaleine



A very efficient gas exchange through the superamphiphobic membrane could be shown.

For the application of the novel membranes in the blood oxygenation in heart-lung machines, the compatibilty with blood is an important property.

A superamphiphobic modified stainless steel mesh was brought into contact with human whole blood. After a predetermined time the whole blood was removed and the protein adhesion on the surfaces was quantified by the known Pierce Test. The values for coated and uncoated meshes can be compared since coated and uncoated meshes are about equal in mass. A significantly reduced protein adhesion could be observed for the superamphiphobic mesh.



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Literature

M. Paven, P. Papadopoulos, S. Schoettler, X. Deng, V. Mailaender, D. Vollmer, H-J Butt: "Super liquid-repellent gas membranes for carbon dioxide capture and heart-lung machines", Nature Communications (2013), 4, 3512, 6 pp

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Patent Information

US9901885 and EP2934728B1 (in DE, FR, GB) granted

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