PATENT BROCHURE

PROCESS FOR THE PREPARATION OF SUPERHYDROPHOBIC FILM

Main Technological Area ⟶ Materials

Keywords⟶ Superhydrophobic film | polymers | PDMS | low-cost technique| large scale manufacturing

The invention relates to an innovative, timely and low-cost process to obtain a thin surface or an optically transparent film presenting marked characteristics of super-hydrophobicity, starting from an ordinary hydrophobic polymer, preferably the polydimethylsiloxane (PDMS), whose chemical formula is $(C_2H_6OSi)_n$.

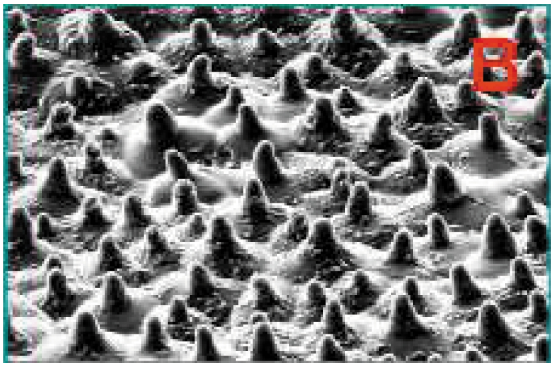

Figure 1 - Surface of the superhydrophobic film

TECHNICAL SPECIFICATIONS

The proposed solution aims to reproduce what happens in nature in plants such as the lotus - hence the term ‘lotus effect’ – in which, due to the conformation of the leaf, the drop of water runs off easily from its surface in the form of drops with an almost perfectly spherical shape.
This condition is realized on the surface of any material when the angle of contact between the drop and the surface itself is very large - typically greater than 140 ° - which preserves the spherical shape of the drop. The ideal case is obviously when the contact angle is equal to 180 °: in this case the drop would be perfectly spherical and tangent to the plane ideally in a single point. One of the ways to achieve such a high contact angle is to operate at a nanometric scale where a super hydrophobic surface is not at all smooth. On the contrary, it looks like a forest of nano-tips, looking more like a fakir's bed than that extremely smooth surface that, by virtue of common sense, maybe what one would expect.

The patented technique consists of a simple procedure, which can be implemented on industrial scale, in order to obtain a super-hydrophobic film using PDMS, forming the above cited nano-tips on which water-based liquids can easily run off, greatly reducing the wet effect.

The process according to the present invention comprises the steps of:

- applying a hydrophobic polymer in the liquid phase on a surface so as to form a layer;
- applying on the layer of hydrophobic polymer a membrane having pores with a diameter smaller than or equal to 3 µm and a pore density of between 10^5 and 6×10^8 pores/cm^2;
- subjecting said layer of hydrophobic polymer to a thermal treatment so as to form a superhydrophobic film;
- removing the membrane cited above (by means of mechanical detachment or, alternatively, by means of chemical degradation with the use of an appropriate solvent)

In the solution described, the corrugations are formed by capillarity, due to the polymer in liquid form diffusing in the pores of the superimposed membrane before the thermal treatment. During the latter, hardening of the polymer and hence formation of the superhydrophobic film is obtained, giving final shape to the artifact.

PDMS is characterized by a remarkable resistance to temperature, to chemical attacks, to oxidation, it is an excellent electrical insulator and resistant to aging; in addition it is optically clean (transparent), it is biocompatible, inert, it is neither toxic nor flammable. This polymer also does not bind either to glass or to metal, nor to the plastic in the phase of solidification, but retains greater adherence on smooth surfaces once solidified. All these properties have made him the most used polymer in the medical field over the years.

INNOVATION/ADVANTAGES

The method according to the present invention:

- Is economically advantageous in terms of raw materials and machining
- Is extremely simple, does not require further subsequent treatments of a photolithographic and/or chemical type;
- Can be applied on a wide scale, even using roll-to-roll technology; the same technique can be applied with other polymers (siloxanes, methacrylates, or fluorinated compounds)
- surface roughness favours scattering of the wavelengths in the spectrum of the visible and of the near infrared, always leading to a reduction and often a total loss of optical transparency; in the case of infrared, the surface can offer an additional thermal isolation.

FIELDS OF APPLICATION

Optical devices	- Self-cleaning coatings for optical and IR sensors
Biomedical	- Coating of the surfaces of catheters and other tubes, also to be permanently implanted, with the great advantage of staying always dry, thus preventing the proliferation of bacteria and other contaminants and responsible for occlusions; the polymer super-hydrophobic is made with bio-compatible material (PDMS) - Pharmaceutical (processing/production): coating of surfaces in contact with liquids (containers and pipes)
Food sector	- Food and Enology (processing/production), coating of surfaces in contact with liquids (containers and pipes) - Solid, or water-base liquid Food Packaging, in order to reduce surface humidity and possible mold growth
Construction sector	- Coating of glass surfaces so as to make them self-cleaning: any drops of rain water, or condensate, would roll on the surface, without wetting it, dragging away the dirt deposited on the glass itself (impurities, particulates). Delay maintenance intervals for buildings with large glass surfaces.
Nautical	- Coating of objects (like hulls) subject to hydrodynamic forces to reduce frictional drag and limit growth of algae and fungus.
Energy sector	- Solar panel coating to make their surface self-cleaning, with consequent delay of maintenance intervals and increased operational efficiency.

PATENT INFORMATION

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