Liquid-Repellent Surfaces Made of Any Materials

Tech ID: 24203 / UC Case 2014-186-0

SUMMARY

UCLA researchers in the Department of Mechanical and Aerospace Engineering have developed a structured surface that can be made of any material (but demonstrated with glass) that repels all liquids (even fluorinated solvents) without using any repellant coating.

BACKGROUND

Liquid-repellant surfaces have long been sough-after for a wide variety of applications ranging from consumer products and outdoor structures to chemical plants. However, such a variety of materials and needs make creating a surface that can work on all types liquids and environmental conditions very difficult. The existing methods of making surfaces liquid-repellant necessitate the material to be hydrophobic or require an application of a hydrophobic coating that will eventually wear off. While there have been efforts to create surface mimicking the liquid-repellant properties of the lotus leaf, none could remain repellent for long without the wax secretion mechanism of the living organism.

INNOVATION

Professor C.J. Kim has devised a surface structure that repels all liquids, including aqueous solutions, organic and fluorinated solvents, that does not require the material to be hydrophobic or for a hydrophobic coating to be applied. This pattern functions regardless of what the solid surfaces are made from. This includes ceramics, metals and polymers. These surfaces are suited for a myriad of applications as a non-degradable or heat-resistant nonwetting surface. For electronic thermal management systems that use refrigerants, they can provide nucleation spots for phase-change heat transfer. The surface can also be made with a gradient pattern for droplet collection, separation, and transportation.

APPLICATIONS

These surface structures may be used in various material embodiments as:

- Non-degradable metal or ceramic hydrophobic surfaces in harsh environments (e.g. high-temperature machine shops)
- Thin films, which can be coated onto any existing surface to be repellent to any liquid (e.g. for the prevention of corrosive chemical contact to critical operating components or infrastructure)
- Nucleation spots in phase-change (e.g. boiling) heat transfer for electronic thermal managements using refrigerants
- Nucleation spots for condensation when the top surface is controlled colder than the cavity, promoting dropwise condensation of hot steams (e.g. for power plant condensers)

ADVANTAGES

- Does not require the material to be hydrophobic
- Does not require a hydrophobic coating to be applied
- Can be used with a wide range of materials (metals, ceramics, polymers)
- Strongly repel “all” known liquids, unlike existing methods

STATE OF DEVELOPMENT

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INVENTORS

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OTHER INFORMATION

CATEGORIZED AS

- **Materials & Chemicals**
  - Ceramics
  - Other
  - Polymers
  - Thin Films
- **Engineering**
  - Other

RELATED CASES

2014-186-0

▶ Working prototypes made of silicon dioxide have been shown in laboratory tests to repel liquids (where the liquids have been successfully suspended and beaded up into mobile droplets with apparent contact angles of ~150°) including:

▶ water

▶ seven different kinds of oils and organic solvents

▶ five different fluorinate solvents

▶ Currently, the invented surface is being applied for two-phase (boiling) cooling with fluorocarbon liquids commonly used for electronic thermal management.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10391530	08/27/2019	2014-186

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Methods of Restoring and Maintaining Gas Film on Superhydrophobic Surfaces while Underwater

▶ A Low-Profile Flow Shear Sensing Unit

▶ Complete Transfer of Liquid Drops by Modification of Nozzle Design

▶ Stereo Image Acquisition By Lens Translation

▶ Method of Fluid Manipulation By Electrodewetting

▶ A Built-In Mechanism Of Gas Maintenance In Microfeatures On A Submerged Surface

▶ No-Assembly Devices for Microfluidics Inside a Cavity

▶ On-chip, Real-time Feedback Control for Electrical Manipulation of Droplets

▶ Micropumping of Liquids by Directional Growth and Selective Venting of Bubbles

▶ Microstructured Cathode for Self-Regulated Oxygen Generation and Consumption

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