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A novel and practical fab-route for superomniphobic liquid-free surfaces

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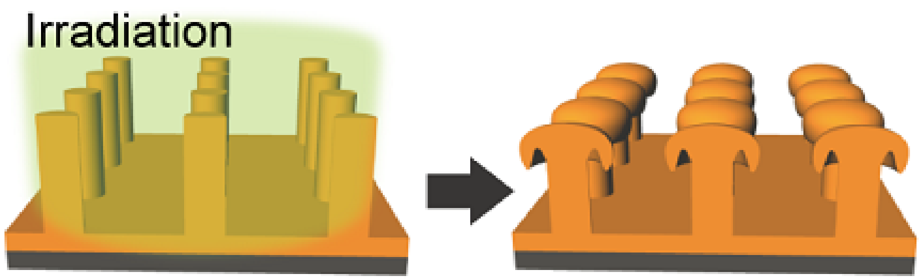


Schematic diagram of mushroom-shaped structure fabrication. Credit: KAIST

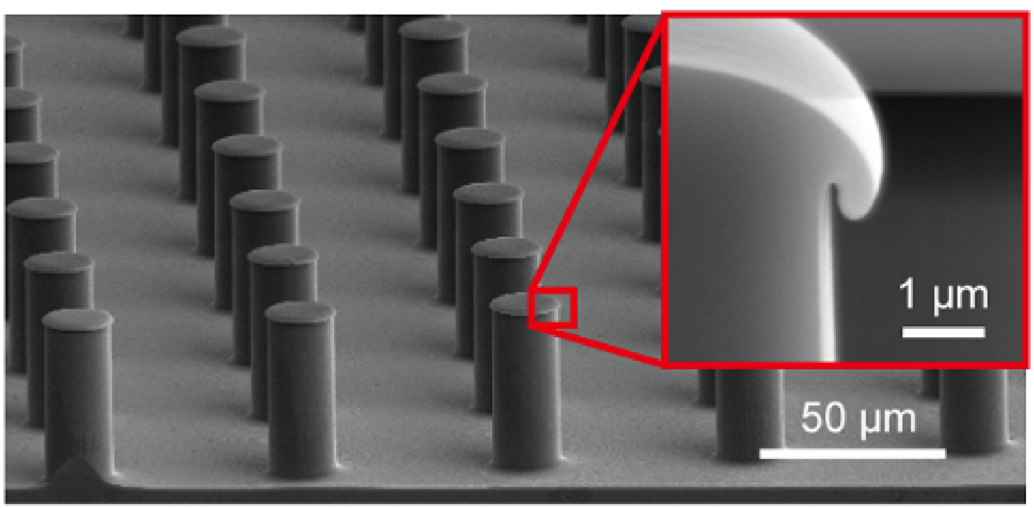
A joint research team led by Professor Hee Tak Kim and Shin-Hyun Kim in the Department of Chemical and Biomolecular Engineering at KAIST developed a fabrication technology that can inexpensively produce surfaces capable of repelling liquids, including water and oil.

The team used the photofluidization of azobenzene molecule-containing polymers to generate a superomniphobic surface which can be applied for developing stain-free fabrics, non-biofouling medical tubing, and corrosion-free surfaces.

Mushroom-shaped surface textures, also called doubly re-entrant structures, are known to be the most effective surface structure that enhances resistance against liquid invasion, thereby exhibiting superior superomniphobic property.

However, the existing procedures for their fabrication are highly delicate, time-consuming, and costly. Moreover, the materials required for the fabrication are restricted to an inflexible and expensive silicon wafer, which limits the practical use of the surface.

To overcome such limitations, the research team used a different approach to fabricate the re-entrant structures called localized photofludization by using the peculiar optical phenomenon of azobenzene molecule-containing polymers (referred to as azopolymers). It is a phenomenon where an azopolymer becomes fluidized under irradiation, and the fluidization takes place locally within the thin surface layer of the azopolymer.



SEM image of mushroom-shaped structure. Credit: KAIST

With this novel approach, the team facilitated the localized photofluidization in the top surface layer of azopolymer cylindrical posts, successfully reconfiguring the cylindrical posts to doubly re-entrant geometry while the fluidized thin top surface of an azopolymer is flowing down.

The structure developed by the team exhibits a superior superomniphobic property even for liquids infiltrating the surface immediately.

Moreover, the superomniphobic property can be maintained on a curved target surface because its surficial materials are based on high molecules.

Furthermore, the fabrication procedure of the structure is highly reproducible and scalable, providing a practical route to creating robust omniphobic surfaces.

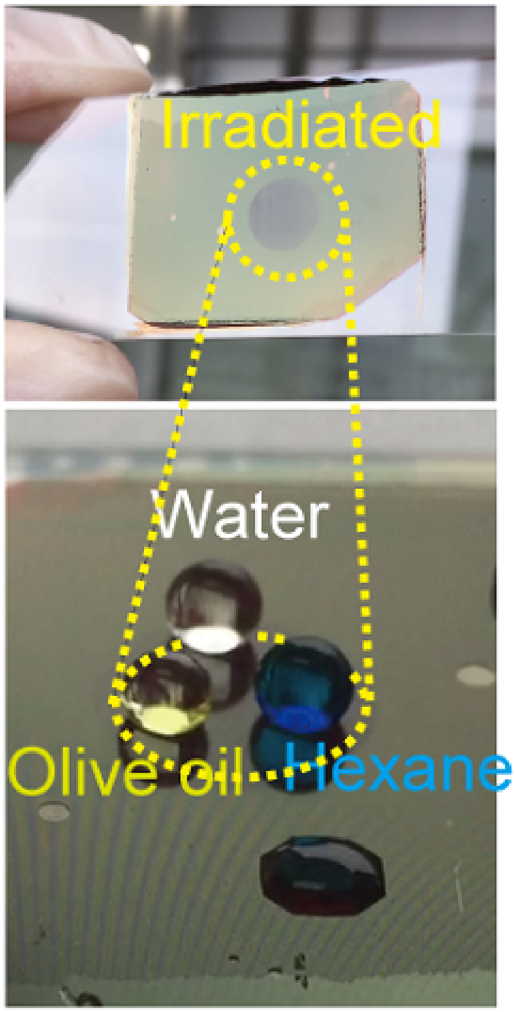


Image of superomniphobic property of different types of liquid. Credit: KAIST

Professor Hee Tak Kim said, "Not only does the novel photo-fluidization technology in this study produce superior superomniphobic surfaces, but it also possesses many practical advantages in terms of fab-procedures and material flexibility; therefore, it could greatly contribute to real uses in diverse applications."

Professor Shin-Hyun Kim added, "The designed doubly re-entrant geometry in this study was inspired by the skin structure of springtails, insects dwelling in soil that breathe through their skin. As I carried out this research, I once again realized that humans can learn from nature to create new engineering designs."

The paper (Jaeho Choi as a first author) was published in *ACS Nano*, an international journal for Nano-technology, in August.

More information: Jaeho Choi et al, Flexible and Robust Superomniphobic Surfaces Created by Localized Photofluidization of Azopolymer Pillars, *ACS Nano* (2017). DOI: 10.1021/acsnano.7b01783

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