Wetting-Empowered Surface Functions for Engineering Applications

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One of the main characteristics of a surface is its ability to be wetted by a liquid. Surfaces can be explicitly designed for full or poor wetting by different liquid types or for the easy sliding or sticking of droplets. The design of functional surfaces crosses multiple length-scales and includes surface chemical functionalization, micro/nano-engineered surface structures, chemical/physical gradients, elasticity, etc. These design features form the basis for even more complex functionalities. Recent approaches have involved increasingly complex surface architectures and techniques such as controlling droplet shape/motion on slippery liquid-infused porous surfaces (SLIPS), and reducing lateral adhesion by employing the Leidenfrost phenomenon (article number 202001249). The importance of this research is underpinned by its role in resolving global challenges, such as environmental crises, sustainable energy, food and water production and consumption.

Sophisticated surface designs often lead to highly functional or multifunctional materials. Their practical use is, however, limited because surface materials need to be mechanically stable/controllable, chemically robust against corrosion or UV radiation, thermally stable, optically transparent, non-toxic, cost effective, etc. The catalogue of practical requirements depends on the specific functionality, the application environment, and the desired lifetime. Research in surface and interface science is now a multifaceted subject. This special issue, "*Wetting-Empowered Surface Functions for Engineering Applications*", focuses on interdisciplinary research into surfaces and interfaces. It demonstrates the understandings of novel surface science, innovative techniques to achieve unique surfaces/interfaces, and the realisation of disruptive structure–property relationships and functions for emerging engineering applications. It highlights the following technical remits, hoping to shed some light on the future advancements in this field.

1. *Customized wetting on a surface* usually requires methodological and instrumental innovations to enable novel surfaces and interfaces. One guiding principle is to take inspiration from biological surfaces to enable higher complexity and controllability, which is usually facilitated by smart materials and structures with other physical inputs (thermal, mechanical, electrical, pH, ionic, and combinations of these stimuli). Many of these developments involve the micro-/nano-engineering of structures through either/both bottom-up (self-assembly, article numbers 202000222 and 202000681) or/and top-down (lithography, etching, laser ablating, etc) approaches, where customized wetting can also be embedded to enhance the processing precision and efficiency. Fabrication routes evolve as the instrumental technology and scientific understanding advance. The resulting solid/liquid interplay is highly controllable, even in an inverse manner such as trapping bubbles in a liquid environment (article number 202001204). All the above approaches have promising application in the wide fields of displays, thin-film devices, microfluidics, solar cells, sensors, actuators, inkjet printing, soft robotics, artificial muscles, flexible electronics, etc.

2. *Surface/interface wetting-enabled sensing/actuating structures and flexible/wearable electronics*. Surface treatment of the substrate to create wetting or de-wetting states has played a key role in electronic manufacturing and has been widely exercised in scaled-up thin film processing for a long time. Recent advancements have explored the potential for droplet shape on the various wetting stages to improve processing precision and efficiency.

Some examples are the surface tension-induced engineering technology (article number 202001201) for inkjet printing of structural coloured hydrogels and a wetting pattern enabled hydrogel actuator (article number 202001211). These strategies resulted in a higher level of 3D reconfigurability, as well as a good compatibility to the existing manufacturing technology. Such advances in fabrication techniques, together with the developments in smart materials, have further driven the innovation of sensing and actuating structures to a higher level of performance. Examples are devices which respond to external stimuli under complex environment (article number 202001443).

Established in 2013, the Smart Materials and Surfaces Laboratory (SMSL) in Northumbria University has achieved considerable progresses in the areas of bio-inspired surface/interface science, smart materials, microdevices and systems, leading to a well-recognized profile in scientific significance and academic impact worldwide. The origin of this special issue is based on discussions among Prof. Butt, Prof. Xu, Dr. Li, and Dr. Smith, starting at the Droplets 2019 conference, which was co-organised by the SMSL.

At last, we hope this collection of papers provides an interesting benchmark for wetting-empowered technological developments toward the discovery of frontier engineering applications. We appreciate the support from the whole editorial team of *Advanced Materials Interfaces* and the reviewers. We would like to gratefully acknowledge the contributions from all authors and their co-authors to this special issue, at this unprecedent time.

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