



Editorial: Particle Interfaces & Interface Performance Materials

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Keywords: particle, interface, Nanobubble, MOFs, nanomaterial

Editorial on the Research Topic

Particle Interfaces & Interface Performance Materials

With the development of colloid and interface science, nanoscience and particuology, the studies on particle systems have shifted from the single and simple system to multiphase, multicomponent and multi-scale complex system, and those on the particle surface and interface have changed from overall interface effect to the local microstructure of interface. Following the fast-paced development in synthesis and measurement technology, interface performance materials (IPMs) family is also expanding from solid-phase materials to liquid-phase materials, e.g., emulsion, gas-phase materials, e.g., bubbles and multiphase mixed systems, where the internal structure of the IPMs is changed from rigid structure such as metal organic frameworks (MOFs), covalent organic frameworks (COFs), hydrogen-bonded organic frameworks (HOFs) and other molecular sieves, to flexible structure such as micelles, vesicles, macromolecules and supramolecular assemblies, multiple and composite structure. This interdisciplinary area involves the physical, chemical and biological interfaces of materials, where the relevant researches have obvious academic significance and great application value for the synthesis, dispersion, stability, surface modification of the materials, and catalysis, drug production, drug delivery, and its biological effects, especially micro- and nanoscale materials. The Research Topic includes volume 1 and 2, where volume 1 has completed last year and volume 2 is opened to call manuscripts now. The editorial comments have summarized the 6 papers published in volume 1 as below.

In terms of IPMs, Lei et al. modeled the binary active/passive colloids systems self-organizing into schools of active colloids with exclusion zone, active crystal core surrounded by passive colloids, yolk/shell structure, dynamical clusters, and motile clusters while exclusion zone is formed when the passive colloids strongly repulse the active colloids. In addition, their study shows that active colloids and passive colloids will separate into two phases when the attraction difference is large enough resulting in the yolk/shell structure and the binary mixture may collapse to a stable mixture when the attractive interaction strength is of comparable magnitude.

Another work from Shuai et al. reported the synthesis of IPMs, where a large number of ions with unsaturated coordination number are generated on the surfaces of brucite and ZnO particles under mechanical grinding, which activates and promotes the hydroxylation and the formation of the associated hydroxyl groups on the particle surfaces by adding NaOH. ZnO/brucite composites prepared by mechanochemical methods result in the dehydration and condensation of the surface hydroxyl groups between the ZnO and brucite particles and the formation of Zn-O-Mg bonds connected by weak hydrogen bonds and van der Waals forces.

To study the particle interface, the gas nanobubbles is becoming very popular nowadays due to their excellent performance in environmental, agricultural and medical fields such as water remediation (Gurung et al., 2016; Xiao et al., 2018), surface cleaning (Wu et al., 2008; Liu,

OPEN ACCESS

Edited and reviewed by:

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Specialty section:

This article was submitted to
Colloidal Materials and Interfaces,
a section of the journal
Frontiers in Materials

Received: 29 April 2022

Accepted: 09 May 2022

Published: 24 May 2022

Citation:

Chen L, Zhang L and Tian T (2022)
Editorial: Particle Interfaces & Interface
Performance Materials.
Front. Mater. 9:931773.
doi: 10.3389/fmats.2022.931773

2009), plant and animal breeding (Ebina et al., 2013), mineral flotation (Sobhy, 2013; Etchepare et al., 2017), medical diagnosis (Yang et al., 2013; Duan et al., 2015) and targeted delivery of genes and drugs (Liu et al., 2017), etc. It is found that there are two states of gas aggregation at nanometer scale. One is bubble-like domains (nanobubbles) and another is gas layers (also called micropancakes) (Zhang et al., 2007; Zhang et al., 2009). The existence of nanobubbles has already been confirmed but the mechanism of their extraordinary stability remains unclear since the publication of first nanobubble images in 2000 (Ishida et al., 2000; Lou et al., 2000). This Research Topic intends to collect the latest advances in explanation on the stability of surface and bulk nanobubbles and provide the latest perspectives in terms of theoretical explanations by considering some important factors such as surface tension, surface chemical heterogeneity and gas saturation, etc (Fang et al., 2018; Zhou et al., 2020). Pan et al. investigated the influence of the variable surface tensions on the stability of surface nanobubbles. They found that the decrease in surface tension can lead to larger contact angle and even make the nanobubbles survivable on the highly hydrophilic surface. The contact angle is also getting larger in the state-dependence, and the increase of the gas saturation degree is beneficial to the stability of surface nanobubbles. Yang et al. studied the influence of surface chemical heterogeneity on the morphology of surface nanobubbles by molecular dynamics simulations. They gave the idea that the gaseous domains could not nucleate on the hydrophilic substrate, while only dense gas layer (DGL) could be observed from the time-averaged density map for homogeneously hydrophobic substrate due to the random moving of surface nanobubbles. Generally, the dynamic process of gas in water involves the dissolution, diffusion, release, and transportation of gas as well as the properties of nanobubbles inside. Wang et al. analyzed theoretically the lifetime of single bulk nanobubbles in an open system by introducing the gas transport parameter in the classical diffusion equation by considering the gas diffusion and the MacLeod-Sugden relationship between the surface tension and densities of liquid and gas. The results showed that the single

nanobubble lifetime depends on the inner density and gas transport length, which can reach 10^{-1} – 10^2 s for a single nanobubble with an initial radius of 200 nm.

The adsorption and recovery of CO_2 has become an important technique to address the increasing environmental challenges. The use of porous materials, especially MOFs has attracted great attention. Although MOFs possess promising properties including high surface area, high porosity and tunable structure, a considerable amount of MOFs are still facing stability challenges, especially moisture stability which significantly affects the practical applications. Watanabe et al. explored the structural change of ELM-11, a commercially available MOFs, in the presence of water and the consequent effects on CO_2 adsorption. The authors found that a subface, which is an isomer of ELM-11 was formed upon water exposure. This finally led to irreversible amorphous phases generated at the subface boundary, resulting in a lower CO_2 adsorption capacity. Coating a water stable MOF shell, ELM-12, on ELM-11 could effectively slow the supply rate of moisture, thus suppressed the subface and amorphous phase formation, and consequently improved the CO_2 adsorption capacity upon water exposure.

In summary, this Research Topic has selected and collected 6 original research papers on gas-liquid interface (nanobubbles), synthesis of IPMs and their adsorption to CO_2 and passive particles, and introduced the recent development on these areas. However, we will continue to attract more high quality works on these areas to be published on volume 2.

AUTHOR CONTRIBUTIONS

LZ edited the section about nanobubbles and TT done some paragraphs on MOFs stuff while LC organized the whole manuscript and edited the nanomaterials section.

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