Fabrication of non-wetting surfaces on aluminum

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In this presentation, the authors introduce our recent studies on fabrication of super-liquid-repellent aluminum surfaces by simple wet processes including anodizing. Such surfaces have many potential applications because of anti-fouling, self-cleaning, corrosion protection and fluid drag reduction properties. Superhydrophobic surfaces can be obtained by introducing surface roughness and reducing the surface free energy. We can obtain superhydrophobic surfaces rather readily because of the relatively high surface tension of water. However, superhydrophobic surfaces are contaminated with oils, so that we need to fabricate oil-repellent surfaces for practical applications. To achieve the super-repellency to low-surface tension oils, well-designed surfaces need to be developed. We have found that hierarchically rough micro-/nano-porous surfaces are suitable for super-repellency even to low-surface tension oils, such as rapeseed oil and octane. The hierarchically rough aluminum surface was obtained by chemical etching of aluminum sheet or mesh in acid solution containing HCl and CuCl2 and following anodizing in H2SO4 solution. The chemical etching formed etch pits on entire surface and the pit size was controlled from several micrometers to submicrometers by increasing HCl concentration. The following anodizing process introduced nanopores without destroying the etch pits morphology.

After fluoroalkyl monolayer coating of the hierarchical surface to reduce the surface free energy, the surface became super-liquid repellent; the static contact angle for water and oils was higher than 150º and the sliding angle was less than 5º. The monolayer coating is not chemically and mechanically stable. Thus, the durability of super-liquid repellency is a main issue for practical applications. We successfully introduced self-healing super-liquid-repellency by infiltrating the healing liquid agent into the nanopore reservoir of anodic alumina. The hierarchically rough aluminum surface was also useful to fabricate slippery liquid-infused porous surface (SLIPS), on which almost all liquids are slippery at tilting angles less than 5º. The SLIPS showed extremely low ice adhesion properties, being applicable to ice-phobic surfaces.