Nature-Inspired Spiky Particles Probed at the Nano-Bio-Interfaces for Drug Delivery

Hao Song*

Australian Institute for Bioengineering and Nanotechnology,
The University of Queensland
Brisbane, QLD 4072 Australia
h.song6@uq.edu.au

The intriguing nature systems have inspired remarkable advances in the development of functional materials with versatile applications. Pollen grains with distinct spiky surfaces are extraordinary delivery vectors in nature, where the rough surface enables strong adhesion towards the hairy legs of honeybees for pollination. The nano-sized viruses also show spiky features, where the protein spikes form multiple 'entry claws' binding to promote cellular invasion. Indeed, surface roughness creates fascinating properties at interfaces, while limited progress has been made using this nature-inspired principle to engineer controllable rough textures onto a nanoparticle for drug delivery applications. In this talk, I will show our patented approach to fabricate silica nanoparticles of spiky surface, especially with precisely-tailored nanotopography. We demonstrated that a rough structure constructed in nanoscale can significantly enhance bacterial adhesion, boosting local delivery of antimicrobial agents.[1, 2] Moreover, the unique spiky nanotopography exhibited strong binding with plasmid DNA, hooking the loop-structured gene molecules for enhanced DNA and vaccine deliveries.[3-4] These nanoparticles were further engineered with tunable asymmetry and surface chemistry, where their interactions with cells and biomolecules were investigated.[5-6] To gain in-depth understanding of this unique nano-bio-interface featuring one side of spiky textures, the adhesion behaviours on various surfaces were characterised by atomic force microscopy using our custom-designed colloidal nano-probes. Apart from the fundamentals and applications of silica-based spiky particles, our recent studies in apply this biomimetic approach to other nano-delivery systems will also be introduced.

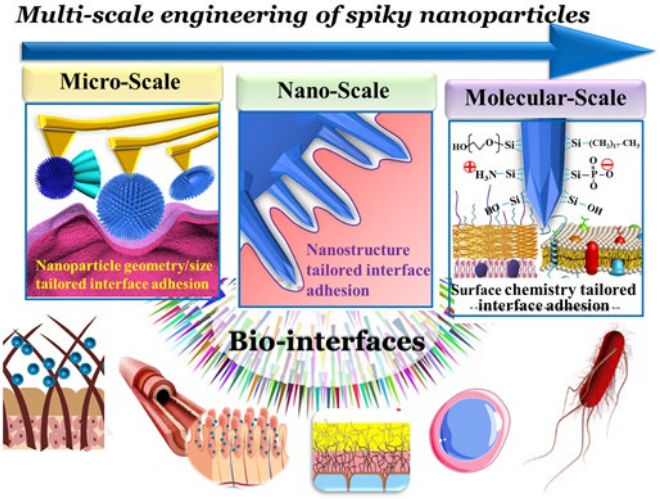

Figure 1: Multi-scale engineering of spiky nanoparticles probed at various bio-interfaces.

References

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