Tuning the biocidal effect, wear-resistance and surface mechanical strength of superhydrophobic coating with ZnO tetrapods via one-step fluorine-free preparation

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Abstract The huge potential of superhydrophobic surfaces for versatile functional applications has attracted enormous attention. Yet, the poor mechanical durability, insufficient antimicrobial property, and potential pollution/health risks upon fabrication impede their wide application. Meanwhile, for use on outdoor porous building substrates (e.g., concretes, stones, bricks, etc.) as protective coatings to counteract natural weathering, superhydrophobic coatings shall also enhance the surface mechanical strength of the decayed substrate. In this study, the coating sols were prepared via a one-pot fluorine-free method, by tuning the molar ratios between trimethoxyoctylsilane (TMOS), ZnO tetrapods (T-ZnO) and SiO_2 nanoparticles. To apply, superhydrophobic surfaces were obtained on substrates effortlessly by brushing/spraying and subsequent gelation of the sols. Exploiting the photocatalytic property and intrinsic bioactivity of T-ZnO, as-prepared coatings showed good biocidal effect. With a very low amount applied (10 g/m^2), the coating prepared with the ratio TMOS/SiO_2/T-ZnO=3/1/1 demonstrated the highest hydrophobicity (166°), as well as the best antimicrobial effects against both Gram-positive/negative bacteria (i.e., 82% and 78% respectively, with the concentration 2.0 mg/mL). Besides, the as-prepared coatings also exhibited high resistance to chemical erosion and mechanical abrasion (withstand 100-cycle tests), owing to the isotropic high mechanical/chemical strength of T-ZnO in the 3D. Moreover, by slightly increasing the coating amount to 30 g/m^2, the surface (0-10 mm) mechanical strength of the substrate improved (~20%), as evidenced by micro-drilling resistance tests. The mechanical strength originated from the polycondensation of TMOS in the presence of T-ZnO, in which T-ZnO acted as the skeleton fillers inside the silica gel networks to further enhance its

strength in the three dimensions. With the facile synthesis and the above desirable properties, as-prepared coatings are promising for the sustained maintenance of outdoor building substrates, and also highlight the broad engineering use of multifunctional superhydrophobic materials.