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Bioinspired Metal Surfaces with Extreme Wettability Contrast

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The exterior structures of natural organisms have continuously evolved by controlling wettability, such as the Namib Desert beetle, whose back has hydrophilic/hydrophobic contrast for water harvesting by mist condensation in dry desert environments, and some plant leaves that have hierarchical micro/nanostructures to collect or repel liquid water. In this work, we have provided a method for wettability contrast on metals by both nano-flake or needle patterns and tuning of the surface energy. Metals including steel alloys and aluminum were provided with hierarchical micro/nanostructures of metaloxides induced by fluorination and a subsequent catalytic reaction of fluorine ions on metal surfaces in water with various ranges from room to boiling temperature of water. Then, a hydrophobic material was deposited on the structured surfaces, rendering superhydrophobicity. Plasma oxidization induces the formation of superhydrophilic surfaces on selective regions surrounded by superhydrophobic surfaces. We show that wettability contrast surfaces align liquid water within patterned hydrophilic regions during the condensation process. Furthermore, this method could have a greater potential to align other liquids or living cells.