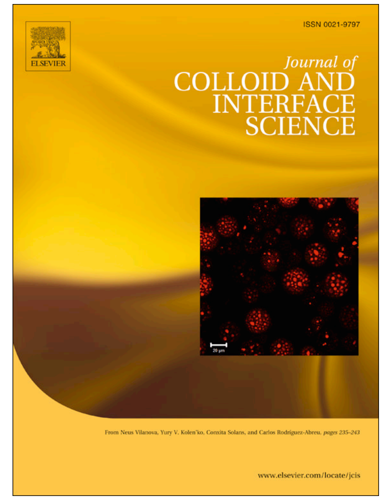


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# A Universal Method to Create Surface Patterns with Extreme Wettability on Metal Substrates

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## Abstract

Extreme wettability surfaces have attracted more and more attention due to their practical applications, however, few reports have shown a universal method to create surface patterns with extreme wettability on a variety of metals. In this paper, a mask-assisted dual-chemical-processing approach without special modification is used to prepare the extreme wettability patterns on various metal substrates. Fabrication of superhydrophilic-superhydrophobic patterns on five kinds of metal substrates of Al, Ti, steel, Zn and Mg alloy proved the versatility of this method. The extreme wettability patterns prepared by this method were applied to fog harvest and we found the big differences in the collection efficiency of various metal surface patterns.

**Keywords**: Extreme wettability; Universal method; Various metal; Fog harvest

## 1 Introduction

Extreme wettability is a special phenomenon in nature due to the microstructures and surface free energy. Wettability refers to the spreading ability of the liquid on a solid surface and is quantified by the contact angle. A solid surface with a water contact angle (CA) higher than 150°[1-4]is a superhydrophobic surface; when the CA of a surface is less than 5°, it is called a superhydrophilic surface. These surfaces have been intensely investigated in different domains thanks to their wide applications in various technical areas such as drag reduction [5], self-cleaning [6-7], anti-icing [8-10], anti-corrosion [11-12], oil/water separation [13-14], etc. Extreme wettability patterns refer to surfaces containing both superhydrophobic and superhydrophilic regions, and these properties enable the control of fluids that are water-based, which have been widely applied in modern science and technology, such as cell growth [15], manipulation of egg quality [16], determination of biomolecules [17] in biotechnology, microfluidic localization in microfluidics, control and mixing of liquid geometry [18-19], lithography [20], etc.

To date, various methods have been developed for the fabrication of extreme wettability patterned surfaces, such as printing technology [21], chemical vapor deposition [22], ultraviolet irradiation [23-24], plasma modification [25-27], etc. Lai et al. [28] fabricated high-accuracy superhydrophobic patterns on a superhydrophobic $TiO_2$ nanotube array (TNA) surface by photocatalytic lithography with a two-step process and can easily control the dimension and morphology of the patterns. Liu et al. altered a fluoroalkylsilane modified superhydrophobic surface to achieve superhydrophilicity using atmospheric pressure plasma treatment, and different superhydrophilic patterns can be obtained with the combination of mask technique. Kinoshita et al. [29] used a laser plasma-type hyperthermal atom beam facility to achieve superhydrophilic-superhydrophobic micro-nanostrucutures on carbon nanotube (CNT) films. Yang et al. [30] fabricated the superhydrophilic-superhydrophobic patterned surface on metal superhydrophobic substrates using a two-step electrochemical-etching method. Combining the masked electrochemical etching and boiling-water immersion methods, they prepared long-term superhydrophilic dimples on the superhydrophobic Al substrate. However, most of methods to creat superhydrophilic region on a superhydrophobic surface require either complex technology or high cost, which has limited applications of extreme wettability patterns. From the perspective of complexity, many fabrication methods are not applied widely in the practical production because of their complicated manipulating process and unstable materials, which are

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