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Supporting information

Nonfluorinated, robust and anti-corrosive polydimethylsiloxane/OTMS functionalized-SiO_2 superhydrophobic coating on Inconel alloy

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Materials

Tetraethyl orthosilicate (TEOS, $Si(OC_2H_5)_4$), octyltrimethoxysilane (OTMS,$CH_3(CH_2)_7Si(OCH_3)_3$), aqueous ammonia (NH_4OH), Ethanol (EtOH, CH_3CH_2OH), Hydrochloric acid (HCl), Tetrahydrofuran (THF, $(CH_2)_4O$), Sodium chloride (NaCl), were supplied by Sigma-Aldrich and SRL Pvt. Ltd. The PDMS resin (sylgard 184 silicone elastomer) and its curing agent were obtained from Dow Corning Co. Inconel 617 substrates purchased from Vishala engineering Co., Hyderabad. SiC papers and Diamond paste were procured from Chennai Metco, India.

Substrate preparation of Inconel 617 alloy

The chemical composition of the received Inconel 617 alloy is presented in Table S1[1]. Inconel 617 substrates were cut using wire cut EDM into pieces with the size of 50 × 50 mm^2, and then finely polished up to 2000 grid size of SiC followed by cloth polishing in diamond paste with particle sizes of 3μm to 1μm. To ensure the substrates were free from surface contaminants, they were then subjected to ultrasonic cleaning (30 KHz, 10min) with deionized water and acetone in sequence to get rid of pollutant on the surface.

Electrochemical experiment

The corrosion behaviors of the specimens were assessed in 3.5 wt.% NaCl aqueous solutions. Electrochemical experiments were conducted at room temperature (30 ℃) using a three-electrode system and an electrochemical workstation from CH Instruments. In this setup, the specimen served as the working electrode exposure area was 1 cm^2, saturated Ag/AgCl as the reference electrode and Pt wire as the counter electrode. To ensure a stable system, the specimens were immersed in the 3.5 wt.% NaCl aqueous solution for over 400 sec before conducting the electrochemical experiments. The potentiodynamic polarization measurements were conducted within a voltage range from -0.6 V to +1.2 V with 10 mV/s scan rate. Impedance conducted within a frequency range of 0.01 Hz to 10^5 Hz.

$$\text{Corrosion rate } \left(\frac{mm}{y}\right) = \frac{0.00327 \times i_{corr}\left(\frac{\mu A}{cm^2}\right) \times E.W\ (g)}{\rho\ (g/cm^3)} \quad (1)$$

Where, i_{corr} is the corrosion current density, E.W is the equivalent weight (29.44 g/equiv.) and ρ is the density (8.36 g/cc) of the IN617 alloy [2].

Characterization

Different analytical instruments were used to characterize two different size OTMS-SiO_2 NPs and IN617/PDMS/OTMS-SiO_2. X-ray diffraction (Empyrean, Malvern Panalytical Instrument) was used to analyze the sample's crystallinity and phase purity with a Cu Kα source (λ = 1.54 Å). X-ray photoelectron spectroscopy (PHI 5000 VersaProbe III, Physical Electronics) was utilized to evaluate the chemical elements using an Al Kα source. Field emission scanning electron microscopy (Zeiss MA15/EVO 18) and atomic force microscopy (Park NX10) were used to examine the sample morphology. Electrochemical Analyzer (CHI760E) was used to evaluate the Tafel and Impedance plots. Water contact angles were measured by a surface analysis instrument (Theta flex, Biolin Scientific) at room temperature.

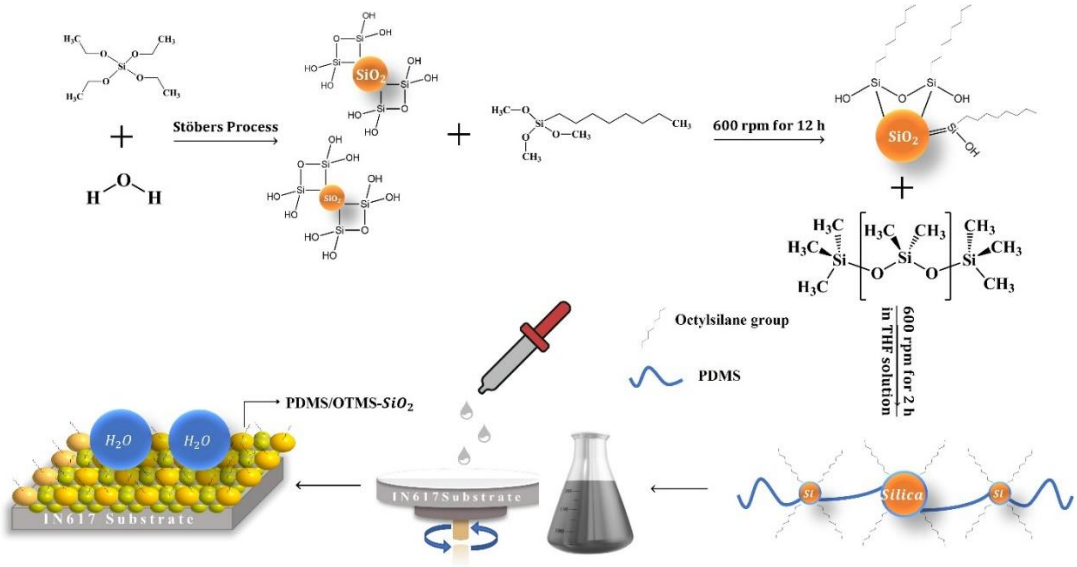

Fig. S1. Schematic representation for preparation of superhydrophobic IN617/PDMS/OTMS-SiO_2 substrate.

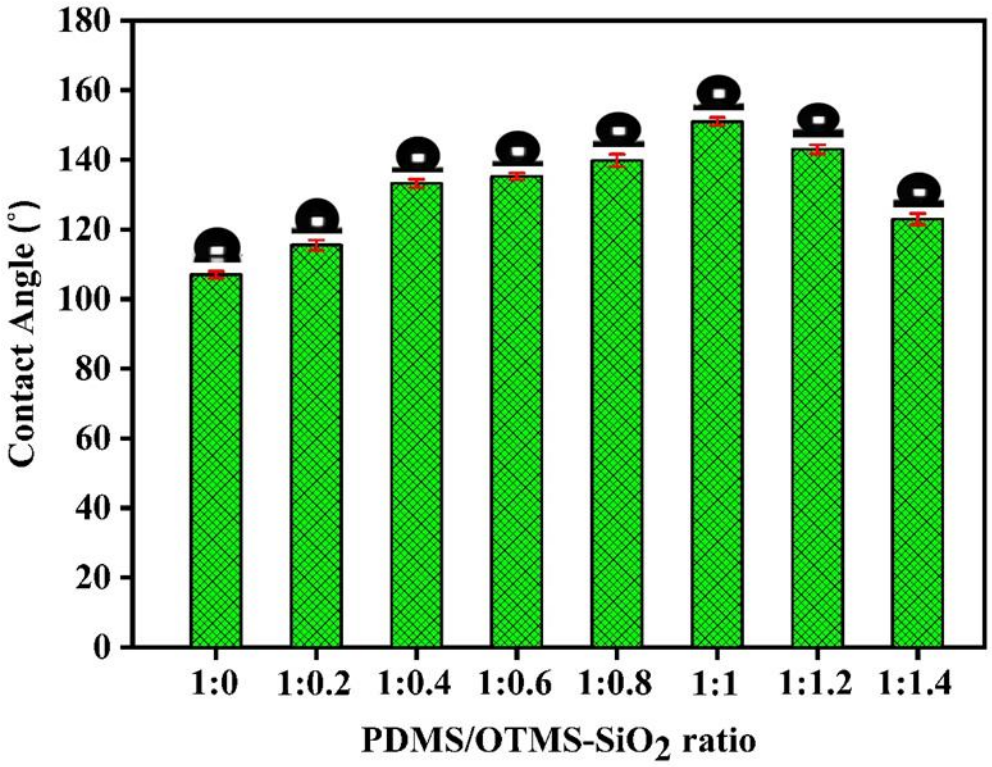

Fig. S2. The effect of OTMS-SiO_2 NPs (wt.) and PDMS (wt.) ratio on WCA.

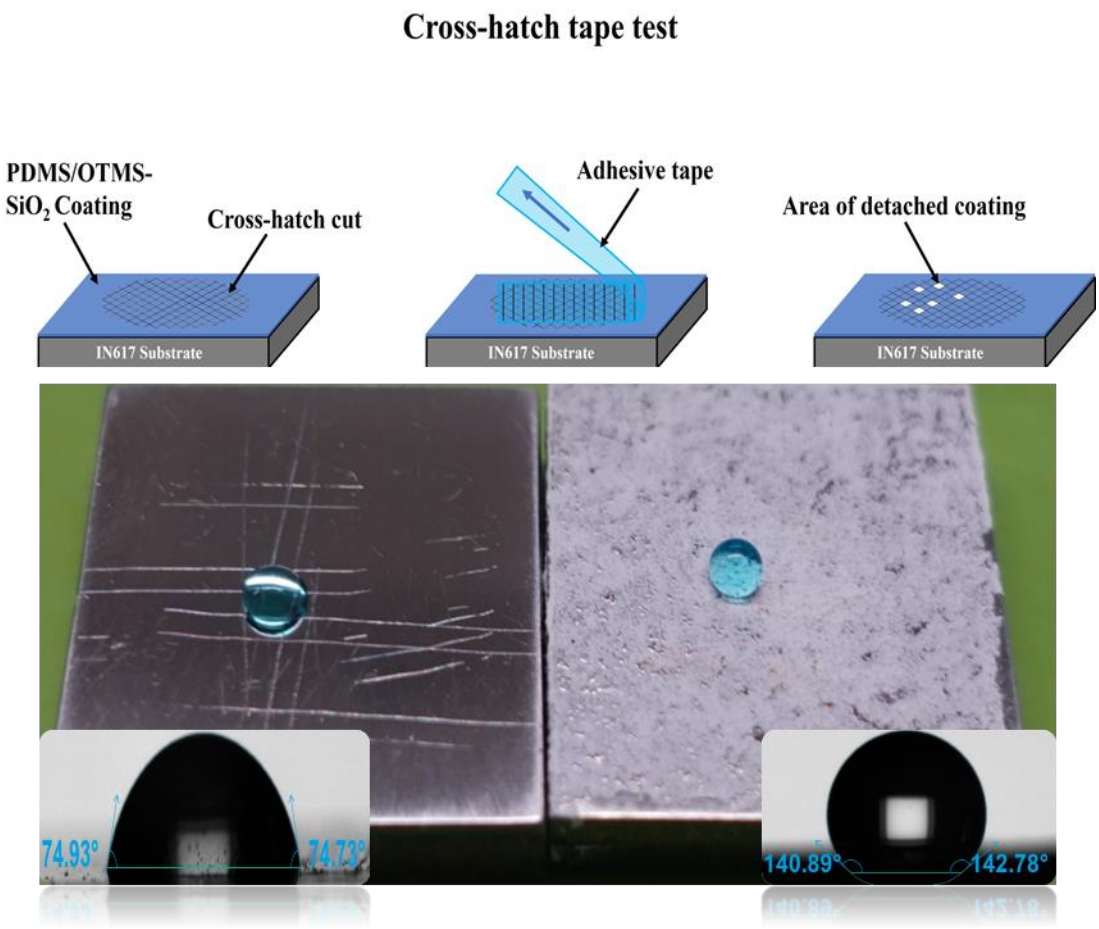

Fig. S3. The cross-hatch tape test (ASTM D 3359) on the IN617 alloy and IN617/PDMS/OTMS-SiO_2, along with a schematic.

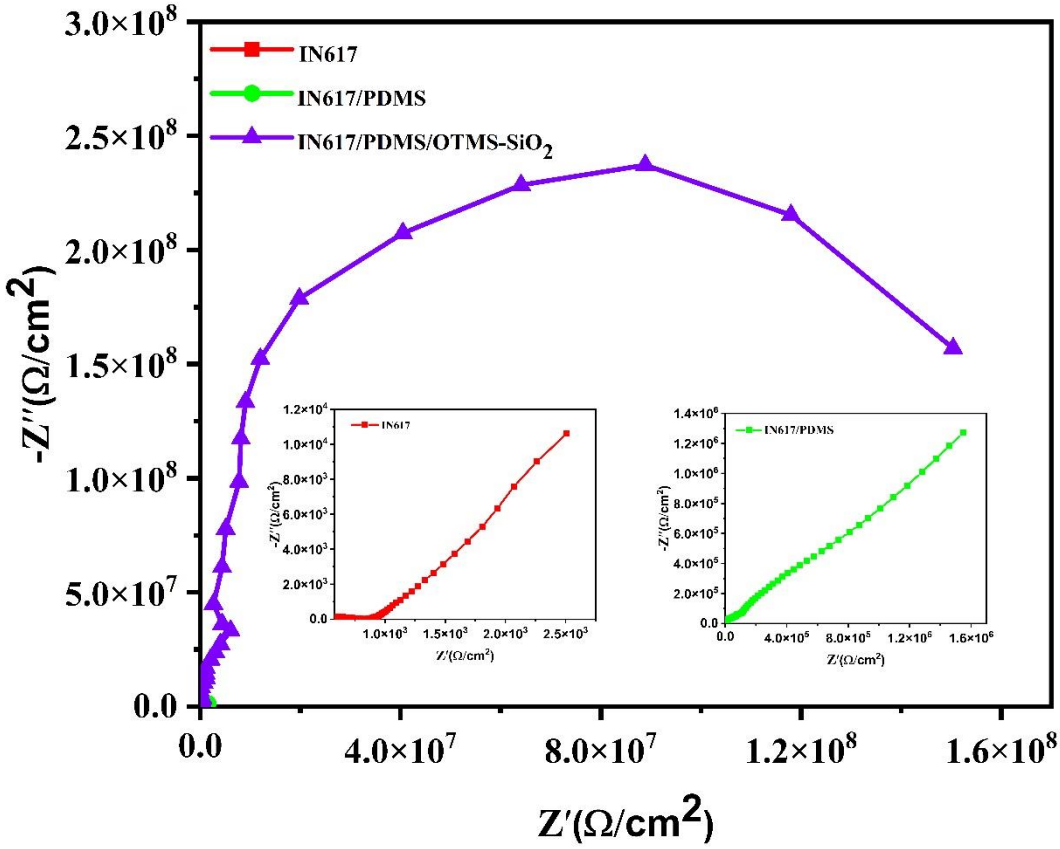

Fig. S4. EIS curves of IN617 substrate, IN617/PDMS and IN617/PDMS/OTMS-SiO_2 composite coatings.

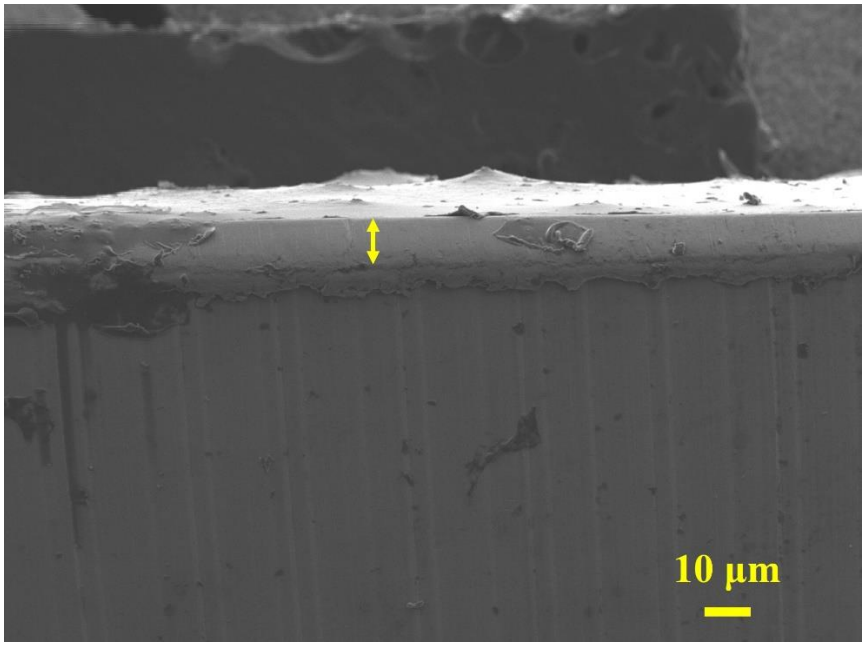

Fig. S5. Cross section SEM of PDMS/OTMS-SiO_2 composite coating on IN617 substrate.

Table S1. IN617 alloy nominal chemical composition

Elements	Ni	Cr	Mo	Co	Fe	Al	Ti	C
Wt.%	44.5	22	9	12.5	3	1.5	0.5	0.07

Table S2. Potentiodynamic polarization parameters (E_{corr} & log I_{corr}) of different samples

Samples	Corrosion potential E_{corr} (V)	Corrosion current log i_{corr} (A/cm^2)	Corrosion rate (mm/y)
IN617	-0.1870	-6.251	6.460×10^{-3}
IN617/PDMS	-0.2889	-8.3168	5.552×10^{-5}
IN617/PDMS/OTMS-SiO_2	0.9300	-10.184	7.537×10^{-7}

References

1 G. A. El-Awadi, S. Abdel-Samad and E. S. Elshazly, *Appl Surf Sci*, 2016, **378**, 224–230.

2 H. W. Ahmad, U. M. Chaudry, M. R. Tariq, A. A. shoukat and D. H. Bae, *J Manuf Process*, 2020, **53**, 275–282.