INTERNATIONAL JOURNAL OF MULTIFACETED & MULTILINGUAL STUDIES

UGC Approved Research Journal (Sr. 47674)

Volume V
Issue II

ISSN : 2394-207X (Print)
IMPACT FACTOR : 4.205

February 2018

A Galaxy of Scholarly Written Research Papers/Articles

IJMMS

Cosmos

VOLUME-V, ISSUE-II

ISSN (Print): 2394-207X
IMPACT FACTOR: 4.205

INTERNATIONAL JOURNAL OF MULTIFACETED AND MULTILINGUAL STUDIES

INTERNATIONAL JOURNAL OF MULTIFACETED AND MULTILINGUAL STUDIES

UGC Approved Research Journal (Sr. 47674)

Editors: Dr. V. H. Mane, Prof. M. P. Shaikh

Language: Multilingual

Published by

INTERNATIONAL JOURNAL OF MULTIFACETED AND MULTILINGUAL STUDIES

Sneh Apartment,
Flat No. 001, Samarth Nagar, New Sangvi,
Pune- 411027

ISSN: 2394-207X (Print)
IMPACT FACTOR: 4.205

VOLUME-V, ISSUE-II

February -2018

Scanned by CamScanner

VOLUME-V (II) Impact Factor: 4.205 ISSN (Print): 2394-207X
INTERNATIONAL JOURNAL OF MULTIFACETED AND MULTILINGUAL STUDIES

Index

Improvement in the Durability of Superhydrophobic Candle Soot Layer using Polystyrene

Rajaram S. Sutar [1], Smita B. Pawar, Tejashwini B. Shinde, Tushar M. Khot, Dipali R. Gade, A. K. Bhosale [1*] and Sanjay S. Latthe [1*]

[1] *Self-cleaning Research Laboratory, Department of Physics, Raje Ramrao College, Jath 416 404, Maharashtra, India.*

Abstract:

Durable superhydrophobic coating has an essential application in daily life and industry. Here, we deposit candle soot layer on cleaned glass slide by holding in middle of candle flame. The deposited candle soot layer has superhydrophobic wetting state, but not mechanically stable. Due to fragile structure of candle soot layer, when water droplets rolls off the surface, almost all of the soot particles are removed by rolling drops. To rectify this problem, we modified candle soot layer by another layer of polystyrene (PS) and enhanced the mechanical stability. After modification water drop easily roll off without carrying candle soot particle.

Keywords: Superhydrophobic, Candle soot layer, Polystyrene, Wetting, Interface

1. Introduction

Many surfaces in nature exhibit superb water repellent property. Water contact angle on superhydrophobic surface has >150° and sliding angle <10°. Lotus leaf surface has very famous example of superhydrophobic property due to micro and nanoscale hierarchical structure consisting of epicuticular wax tubules [1]. Spherical shaped water droplets collects dust particles from Lotus leaf and roll-off. This mechanism is called *Lotus leaf effect* or *self-cleaning effect* [2]. In Cassie-Baxter state [3] superhydrophobic surfaces exhibit air in between water drop and micro- and nano-scale rough surface, which reduce contact area between the liquid and solid surface. On such type of surfaces, the water droplets can easily roll off. In last three decades many researchers tried to fabricate the superhydrophobic surfaces, which mimics the property of water repellent Lotus leaf. The researchers fabricated superhydrophobic coatings by using nanoparticles such as TiO_2 [4], SiO_2 [5], ZnO [6], ZrO, Al_2O_3 [7], Fe_3O_4 [7] and carbon nanoparticles (Collected from candle soot) [8] with polymer composition. The nanoparticle/polymer nanocomposite coated on various substrates via different deposition techniques such as chemical immersion technique, spray coating [9], drop casting, electrospinning technique [10] and electrospray, chemical vapour deposition [11] and many.

The research group of Liang [12] have reported that candle soot is one of the important material with carbon nanoparticles diameter in between 20 – 35 nm can be used for superhydrophobic coatings. The candle soot can be cheaply and easily collected without costly instruments and chemicals. The inner flame soot particle has smaller than tip flame soot and superhydrophobic as well as superoleophilic. Yuan et al [13] have coated superhydrophobic candle soot (burning of candle) on a low-density polyethylene substrate. This superhydrophobic coating showed excellent superhydrophobic property under condensation. Deng and co-researcher [8] have reported the easy-to-fabricate oil- and water-repellent coating made from soot encased in a silica shell. The low-surface-tension drops of liquid roll off easily when the surface is tilted by 5°, taking impurities along with them. Liu *et al* [11] have prepared robust and antireflective superhydrophobic surfaces by deposited candle soot cured using polydimethylsiloxane (PDMS) via CVD. Herein we report the fabrication of durable superhydrophobic coating using cheap candle soot nanoparticles and polystyrene.

2. Experimental Section

2.1 Materials : Polystyrene (average Mw~192000 obtained from Sigma Aldrich, USA), Glass slides (75 mm long X 25 mm wide) were purchased from Polar Industrial Corporation Mumbai (India), Toluene (99.5%) was purchased from Loba Chemie Pvt. Ltd. Mumbai (India), Candle were purchased from local market.

2.2 Deposition of candle soot: The candle soot was deposited on glass slide by holding in middle of flame. Deposition of a soot layer turns the glass plate completely black after 1min. This candle soot deposited sample showed water contact angle greater than 160° and water drop impact test confirms that the adhesion between carbon-carbon nanoparticles, carbon nanoparticle and glass surface is very weak. The deposited carbon soot washed away with water drops.

2.3 Modification of deposited candle soot layer with PS: The polymer solution was prepared by varying concentration of PS (2, 4, 5 and 6 mg/ml) in toluene. The mixture of polystyrene and toluene was kept in ultrasonication bath at 30 min. The candle soot was deposited on clean glass slide by holding in middle of the candle flame. Candle soot deposited slides were coated by PS solution via dip coating technique. We prepared the coatings at dipping time 6 min. After that this prepared sample was dried at 100°C for 1 hour. Here deposited candle soot layer modified by four different concentration of polystyrene solution.

3. Results and discussion:

Water contact angle and sliding angle were measured on these modified candle soot layer. As shown in Fig. 1, the water contact angle was varied from 130° to 160° for different concentration of PS.

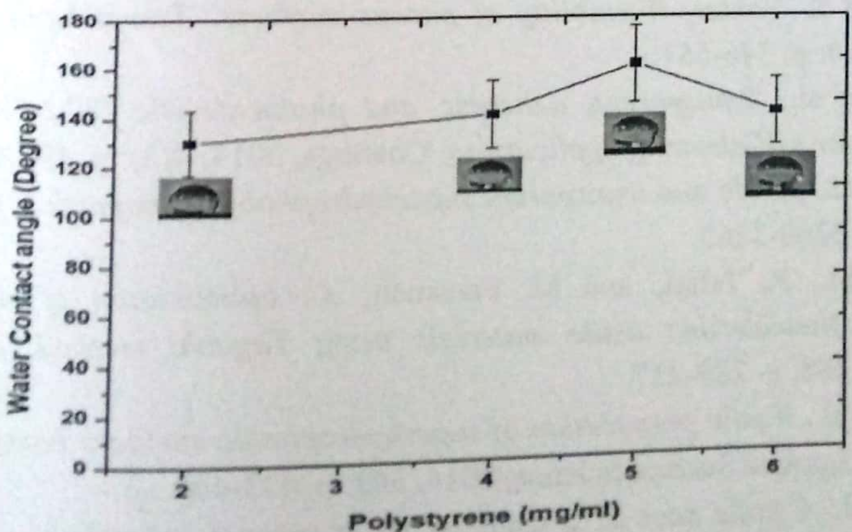

Fig. 1. The water contact angle after different concentrations of polystyrene layer on candle soot layer.

The candle soot layer coated with PS concentration of 2 mg/ml and 3 mg/ml, the water contact angles of 130° and 140° were observed. Actually, the WCA for only candle soot layer was observed around 160° due to rough structure and after applying the low concentrated PS layer, the toluene might have crumbled the 3 – D network structure of candle soot which results in decrease in WCA. After application of 5 mg/ml PS layer, candle soot layer exhibits water contact angle nearly 160° and showed sliding angle less than 10°. This PS concentration is critical concentration, where the network structure is intact and polymer might tightly bind all the candle soot. This sample also tested under water jet impact test, it showed most stable as compared to without polystyrene modified candle soot layer. However the 6 mg/ml PS layer might smoothened the rough structure of candle soot and as a result the contact angle decreased to 132°. The air pocket formation in rough structure of the coating is most important to achieve superhydrophobic coating for self-cleaning applications.

Conclusion: Herein, we have demonstrated a simple way to enhance stability of weakly interacted candle soot particle with each other and with surface of substrate. We achieved water contact angle ~160° and sliding angle less than 10° of carbon soot coating after applying the 5 mg/ml concentration of polystyrene layer via dip coating technique. These coatings were cheaply prepared as candle soot can be collected easily from the flame of candle.

Acknowledgment: This work is financially supported by DST-INSPIRE Faculty Scheme, Department of Science and Technology (DST), Government of India. [DST/INSPIRE/04/2015/000281].

References

1. Ensikat, H.J., et al., *Superhydrophobicity in perfection: the outstanding properties of the lotus leaf.* Beilstein journal of nanotechnology, 2011. **2**: p. 152.
2. Barthlott, W. and C. Neinhuis, *Purity of the sacred lotus, or escape from contamination in biological surfaces.* Planta, 1997. **202**(1): p. 1-8.
3. Cassie, A. and S. Baxter, *Wettability of porous surfaces.* Transactions of the Faraday society, 1944. **40**: p. 546-551.
4. Latthe, S.S., et al., *Transparent, adherent, and photocatalytic SiO2-TiO2 coatings on polycarbonate for self-cleaning applications.* Coatings, 2014. **4**(3): p. 497-507.
5. Ling, X.Y., et al., *Stable and transparent superhydrophobic nanoparticle films.* Langmuir, 2009. **25**(5): p. 3260-3263.
6. Mohamed, A.M., R. Jafari, and M. Farzaneh, *An optimization of superhydrophobic polyvinylidene fluoride/zinc oxide materials using Taguchi method.* Applied Surface Science, 2014. **288**: p. 229-237.
7. Bao, X.-M., et al., *Facile preparation of superhydrophobic surfaces based on metal oxide nanoparticles.* Applied Surface Science, 2014. **303**: p. 473-480.
8. Deng, X., et al., *Candle soot as a template for a transparent robust superamphiphobic coating.* Science, 2012. **335**(6064): p. 67-70.

9. Ogihara, H., et al., *Simple method for preparing superhydrophobic paper: spray-deposited hydrophobic silica nanoparticle coatings exhibit high water-repellency and transparency.* Langmuir, 2012. **28**(10): p. 4605-4608.

10. Liu, Z., et al., *Superhydrophobic poly (vinylidene fluoride) membranes with controllable structure and tunable wettability prepared by one-step electrospinning.* Polymer, 2016. **82**: p. 105-113.

11. Liu, X., et al., *Robust and antireflective superhydrophobic surfaces prepared by CVD of cured polydimethylsiloxane with candle soot as a template.* RSC Advances, 2015. **5**(2): p. 1315-1318.

12. Liang, C.-J., et al., *Relationship between wettabilities and chemical compositions of candle soots.* Fuel, 2014. **128**: p. 422-427.

13. Yuan, Z., et al., *Facile preparation of superhydrophobic candle soot coating and its wettability under condensation.* Applied Physics A, 2016. **122**(2): p. 125.