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Nesting Site and Nesting Material of House Crow (*Corvussplendens*) In Raje Ramrao College Campus, Jath, Dist. Sangli (M.S.), India.

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Abstract

The present study was carried out the nesting site and nesting material of house crow in Raje Ramrao College campus, Jath. The total area of campus is 28.33 acres. Total 33nests were repaired to identify the nest materials. Out of these 6 nests on Neem tree, 16 on Nilgiri, 1on Peepal, 8 on Ashoka tree and 2 on Coconut tree. The majority of nests which were observed on Nilgiri trees in between 2 to 3 branches. The observed nest materials are twigs, dried large sticks, dried grass, paper piece, pieces of wire, plastic threads, fibers of coconut tree. Plant leaf and unidentified material are also present inside of the nest. The majority of material which is used for constructing the nests are dried sticks and grasses. To identify the nest materials somewhere was observed.

The present work is focused on nesting sites and nesting material of *Corvus splendens* as because there is no detail study available in this campus area.

Keywords: Nesting site, nesting material, College campus, Maharashtra.

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'इक्कीसवीं सदी की कविताओं में चित्रित आदिवासी जीवन'

प्रा. हिरामण देवराम टोंगारे
विभाग प्रमुख हिंदी
राजे रामराव महाविद्यालय, जत. जि. सांगली.

इक्कीसवीं सदी विमर्शो की सदी मानी जाती है। जिसमें अनेक समूह अपनी अस्मिता की लडाई एक न्यायिक धरातल पर लड रहे हैं। जिसमें एक सुव्यवस्थित विचारधारा केंद्र में है। इस वैचारिक विमर्शों में प्रमुख हैं – स्त्री विमर्श, दलित विमर्श, पुरुष विमर्श, तृतीय पंथी विमर्श, अल्पसंख्याक विमर्श तथा आदिवासी विमर्श आदि। इक्कीसवीं सदी में जो लोग हाशिये पर थे वे केंद्र में आने लगे हैं इस हाशिये पर रहनेवाले समाज को केंद्र में लाने में विभिन्न पत्र–पत्रिकाओंका, साहित्यकारों का, सामाजिक–सांस्कृतिक आंदोलन तथा राजनीतिक आंदोलन आदि का खासा हाथ रहा है। हाशिये से केंद्र की ओर प्रस्थान की यात्रा आदिवासी विमर्श की अपनी एक अलग ही दास्तान है। आदिवासी समाज को अबतक वर्चस्ववादी समाजव्यवस्था ने हाशिये पे ही रखा है। समय परिवर्तन एवं भारतीय संविधान ने इस समाज को अपने अधिकार की लडाई लडने के लिए प्रेरित किया है। साहित्यिक परिप्रेक्ष्य में आदिवासी विमर्श को स्त्री विमर्श तथा दलित विमर्श ने काफी हद तक प्रभावित किया है। आदिवासी विमर्श फिलहाल में अचानक उपजा हुआ कोई साहित्यिक आंदोलन नहीं है इसका इतिहास जानने हेतु भूतकाल के गुफाँगार गुफों में प्रवेश करना पड़ेगा। आदिवासी जनजीवन की पीडा, अभावग्रस्तता को केंद्र में रखकर हिंदी में अनेक गैर अदिवासी साहित्यकारों ने अपनी कलम चलायी है। जिसमें प्रमुख है – आलोक धन्वा, महाश्वेता देवी, संजीव, राकेश सिंह, विनोदकुमार शुक्ल आदि।

आदिवासी जनजीवन की अभावग्रस्तता को केंद्र में रखकर विनोदकुमार शुक्ल 'अतिरिक्त नही' कवितासंग्रह में लिखते हैं,

> जंगल के उजाड में
> कांदा खोदते–खोदते भूख से बेहोश पडे
> आदिवासी के लिए कौन डॉक्टर को बुलाएगा
> उसे अस्पताल ले जाना चाहिए या रसोई घर।

–'जंगल के उजाड में'

प्रस्तुत कविता में आदिवासी समाज की दयनीय स्थिति का चित्रण हुआ है। आदिवासी साहित्य एवं गैर आदिवासियों की सोच पर टिप्पणी करती हुई वंदना टेटे लिखती है, ''आदिवासियों का 'कहना' बिखरा हुआ है, उनकी मूल भाषाओं में और हिंदी व गैर हिंदी भाषाओं में भी।... कि उनसे या तो 'बेचारगी' का चित्र बनता है या फिर 'क्रांति' के लिए हिंसा (संघर्ष) करते हुए आदिवासियों का। बेचारगी और क्रांति ये दो ही स्थितियाँ हैं, जिनकी परिधि में वे आदिवासियों को देखते हैं। चूँकि गैर– आदिवासी समाज में उनका बड़ा तबका, जो भूमिहीन और अन्य संसाधनों से स्वामित्वविहीन है, 'बेचारा' है, इसलिए वे सोच भी नहीं पाते कि इससे इतर आदिवासी समाज, जिसके पास संपत्ति की कोई निजी अवधारणा नहीं है, वह बेचारा नहीं है। वे समझा ही नहीं पाते कि उसका नकार 'क्रांति (सत्ता) के लिए किया जानेवाला प्रतिकार' नहीं, बल्कि समष्टि के बचाव और सहअस्तित्व के लिए है। जो सृष्टि ने उसे इस विश्वास के साथ दिया है। कि वह उसका संरक्षक है, स्वामी नहीं।''**(लोकप्रिय आदिवासी कहानियाँ पृ.8)** वास्तव में आदिवासी समाज के संदर्भ में गैर आदिवासी रचनाकारों का मूल्यांकन सहानुभूतिपरक रहा है। आदिवासी जीवन की पीडा को भोगे बिना उसका मूल्यांकन प्रामाणिकता की कसौटी पर कमजोर लगता है। आदिवासी समाज की लडाई जल, जंगल, जमीन की लडाई है। उनकी यह लडाई समष्टि के बचाव एवं सहअस्तिव के लिए है। वो सृष्टि का स्वामी नहीं, संरक्षक बनना चाहता है। इक्कीसवीं सदी की आदिवासी कवियों की कविताएँ आदिवासी समाज के अधिकार की माँग करती है, वो सत्ता के दमन एवं अन्याय का प्रतिरोध करती है।

भारतीय संविधान के तहत आदिवासी समाज की जमीन गैर आदिवासी खरीद नहीं सकता है। लेकिन पूँजीवादी व्यवस्था ने आदिवासियों से उनका अधिकार छीन लिया है। इसीकारण कई आदिवासी लोग एवं गाँव विस्थापन की समस्या से क्षतिग्रस्त है। हाल ही में सरदार पटेल की मूर्ति के लिए गुजरात में

कई आदिवासी गाँव क्षतिग्रस्त हुए हैं। इस समस्या को 'वापसी' नामक कविता में रामदयाल मुंडा नामक आदिवासी कवि उठाते हैं,

"तब और अब और उसके बीच का सारा समय निश्चल खड़ा है।
तब, वह भाग गया था अपना गाँव छोड़कर।
अब, उसका गाँव भाग गया है
उसे छोड़कर।"

(लोकप्रिय आदिवासी कविताएँ, पृ.53)

आज आदिवासी लड़की एवं स्त्री का सौंदर्य चित्रण सस्ती मनोरंजकता के स्तर तक गैर आदिवासी कवियों की कविता में चित्रित हुआ है। ऐसे कवियों की मानसिकता एवं सौंदर्य बोध पर व्यंग्य करते हुए हरिराम मीणा आदिवासी लड़की नामक कविता में लिखते हैं,

आदिवासी युवती पर
वो तुम्हारी चर्चित कविता
क्या खूबसूरत पंक्तियाँ–
'गोल–गोल गाल
उन्नत उरोज
गहरी नाभि
पुष्ट जंघाएँ
मदमाता यौवन'
यह भी तो कि–
नायिका कविता की
स्वयं में संपूर्ण कविता
ज्यों
हुआ साकार तन में
प्रकृति का सौंदर्य सारा
रुप से मधु झरे रहा
एवं
सुगंधित पवन उससे
अहा,
क्या कहना कवि
तुम्हारे सौंदर्य –बोध का!
अब इन परिकल्पित – ऊँचाइयों पर
स्वप्निल भाव – तरंगो के साथ उड़ते
कलात्मक शब्द–यान से नीचे उतरकर
चलो उस अंचल में
जहाँ रहती है वह आदिवासी लड़की
अपना रंगीन चश्मा उतारकर देखो
लड़की की गहरी नाभि के भीतर
पेट में भूख से सिकुड़ी उसकी आँतों को
सुनो उन आँतों का आर्तनाद
और
अभिव्यक्त करने के लिए
तलाशों कुछ शब्द अपनी भाषा में
उतरो कवि,
लड़की की पुष्ट जंघाओं के नीचे
देखो पैरों के तलुओं को
बिवाइयों भरी खाल पर

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छाले – फफोलों से रिसते स्त्राव को देखो
कैसा काव्य – बिंब बनता है कवि
(लोकप्रिय आदिवासी कविताएँ, पृ.137)

प्रस्तुत कविता गैर आदिवासी साहित्यकारों की मानसिकता एवं सौंदर्य बोध पर सटीक टिप्पणी करती है। हाल ही में दिनकर मनवर नामक कवि की मराठी कविता 'पाणी कसं असत' में आदिवासी लडकी के ऊरोजों पर टिप्पणी की थी। इस प्रकार से लिखनेवाले कवि आदिवासी लडकी के उस सौंदर्य पर कोई टिप्पणी नहीं करता है, जो चौथे दशक में प्रेमचंद ने माँग की थी। आदिवासी कवि सौंदर्यशास्त्र के पुराने मानदंडो के खिलाफ विद्रोह करता है। महाश्वेता देवी जैसे गिने –चुने साहित्यकारों को छोड दिया जाये तो आदिवासी जनजीवन सही परिप्रेक्ष्य में चित्रित कर पाने में गैर आदिवासी रचनाकार सफल नहीं हुए है।

आदिवासी कवि आर्थिक, सामाजिक एवं राजनीतिक विषमता के खिलाफ विद्रोह करता है। परंपरा से आदिवासी समाज को शैक्षिक एवं आर्थिक व्यवस्था में हाशिये पर रखा गया है। यह विषमता व्यवस्था के द्वारा बनायी गयी है। आदिवासी समाज के लिए योजना आयोग में ढेर सारी सुविधाओं का प्राव्धान है, संविधान में अदिवासी समाज के विकास हेतु विशेष प्रावधान किया गया है। लेकिन उसका लाभ आदिवासी समाज तक नहीं पहुंचा है। इसके लिए जिम्मेदार है राजनीतिक व्यवस्था। आर्थिक एवं शैक्षिक विषमता के खिलाफ आदिवासी कवि अपनी आवाज बुलंद कर देता है और इस व्यवस्था को सवाल पूछता है। इस परिप्रेक्ष्य में निर्मला पुतुल 'अगर तुम मेरी जगह होते' कविता में लिखती हैं,

जरा सोचो, कि
तुम मेरी जगह होते
और मैं तुम्हारी
तो, कैसा लगता तुम्हें?
कैसा लगता?
अगर उस सुंदर पहाड की तलहटी में
होता तुम्हारा गाँव
और रह रहे होते तुम घास–फुस की झोंपडियों में
गाय, बैल, बकरियों और मुर्गियों के साथ
और बुझने को आतुरे ढिबरी की रोशनी में
देखना पडता भूख से बिलबिलाते बच्चों का चेहरा
तो, कैसा लगता तुम्हें?
(लोकप्रिय आदिवासी कविताएँ, पृ. 152)

आदिवासी कवियों द्वारा चित्रित यह समाजबोध एवं वर्गविषमता परंपरागत मार्क्सवाद का अनुकरण मात्र नहीं है। यह विषमता बोध को उन्होंने अपने जीवन की पथराली पगडंडीयों के अनुभव से प्राप्त किया गया है, उसमें अनुभव की प्रामाणिकता साफ झलकती है।

आज आदिवासी विमर्श सिर्फ जल, जंगल, जमीन की लडाई तक सीमित नहीं रहा है। वो आदिवासी अस्मिता, संस्कृति, अधिकार, राजनीतिक एवं सामाजिक बदलाव के क्षेत्र में फैल गया है। जो व्यवस्था मेडपरिवर्तन की माँग करता है।

संदर्भ:

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Nesting Site and Nesting Material of House Crow (Corvussplendens) In Raje Ramrao College Campus, Jath, Dist. Sangli (M.S.), India.

Dr. [illegible][1], Dr. S. B. Deshmukh[2], Dr. M. B. Sajjan[2], Mr. M. H. [illegible][2]
Asst. Prof. Department of Zoology, Raje Ramrao Mahavidyalaya, Jath
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Abstract

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संगीत देवबाभळी : आकलन आणि आस्वाद

प्रशांत नागावकर

डॉ. ज्ञानेश्वर कांबळे

प्रशांत नागावकर आणि डॉ. ज्ञानेश्वर कांबळे यांनी साकारलेला, 'संगीत देवबाभळी'वरील संदर्भ ग्रंथ या नाटकाच्या आकलनास मोलाची मदत करणारा आहे. या ग्रंथाचे वेगळेपण असे की, तो नाट्य इतिहास नाट्यशास्त्राच्या परंपरा यांचा परामर्श घेत 'संगीत देवबाभळी'कडे येतो. असे केल्याने संशोधकांना, विद्यार्थ्यांना, अभ्यासकांना 'संगीत देवबाभळी'ची स्थाननिश्चिती करणेही शक्य होते. नाटक हे एकाच वेळी साहित्यही असते आणि प्रयोगरूप कलाही असते. मराठीत; नाटकाच्या प्रयोगरूपाच्या संशोधनाची फारशी परंपरा नाही. साहित्याचे अभ्यासक तर नाटकाच्या प्रयोगरूपाचा अनुल्लेखच करत आलेले आहेत. (याचप्रमाणे नाटकाचे अभ्यासक नाटकाच्या साहित्यापणाचा अनुल्लेख करत आलेले आहेत.) याने वर्षानुवर्षे नाटकाचा संहितानिष्ठ अभ्यास करणाऱ्याला नाटकाच्या प्रयोगाचे अंग उमजूनच येत नाही. अनेकदा नाटकाचे अध्यापन, कंस सूचना वगळून झाल्याचे मी स्वतः पाहिलेले आहे. साहित्याचे विद्यार्थी नाटकाच्या प्रयोगरूपाशी अनभिज्ञ राहतात. मराठीच्या वर्गांमध्ये प्रकट वाचनाची परंपराही क्षीण आहे. यामुळे नाटकाची श्राव्यशक्तीही दुर्लक्षित राहते. परिणामी साहित्यकेंद्री अभ्यासात नाटकाचे दृश्यमूल्य आणि श्राव्यमूल्य दोन्हीही अनुपस्थित असते. नागावकर स्वतः रंगकर्मी असल्याने त्यांना ही कमतरता जाणवली असावी. प्रस्तुत ग्रंथात नाटकाचे वाङ्मयीनरूप आणि प्रयोगरूप अशा दोन्हीही अंगांची चिकित्सा झालेली आहे आणि त्यांचा परस्पर संबंधही उलगडून पाहिलेला आहे. असा संबंध उलगडून पाहणे हे या ग्रंथाचे वेगळेपण ठरावे.

–डॉ. हिमांशू भूषण स्मार्त

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Chapter No. 15

Candle Soot Modified Superhydrophobic/ Superoleophilic Surfaces for Oil-Water Separation: A review

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Abstract-

Over many years, the oceanic oil spill accidents and the discharging of immense oil levels in the surroundings of most industries worldwide have been a serious environmental problem. Oil and organic pollutants in water has a severe problem for aquatic life and human being. There is a need to develop technology for oil-water separation because the spilled oil affects the ecological and environmental system. Recently, superhydrophobic/superoleophilic sponges, metal meshes, membranes, and porous materials have played crucial roles in separating oil from oil-water mixture. The micro and nanopores of the substrate facilitate to entry of liquid into it and superhydrophobic/superoleophilic properties of the substrate surface resist water and allow oil to enter into the porous substrate. Candle soot has the advantages of cost-effectiveness and production scalability over other carbons like graphene, carbon nanotubes, carbon nanodots, etc. in their synthesis. Candle soot-coated superhydrophobic materials have outstanding water repulsion and oil absorption capacity, high selectivity, chemical inertness, and excellent recyclability. This paper discusses applications of candle soot-coated superhydrophobic materials for oil-water separation.

Keywords: *Candle soot, oil-water separation, sponge, stainless steel mesh, and superhydrophobic.*

Introduction-

During the past few years, water pollution resulting from oil spillage and industrial organic pollutants has emerged as a serious issue on a global scale, imposing threats to the ecosystem, human health, and economic growth. To overcome this challenge, many efforts have been made to develop efficient absorbents such as activated candle soot nanoparticles, carbon nanotube sponges, carbon nanodots sponges, candle soot/polymer composites, and graphene sponges for separating and removing the contaminants from water. Among all these absorbents, candle-soot-based absorbents demonstrate superior efficiency in the removal of oils. However, the high production costs of these absorbents limit their wide adoption. Candle soot generated from incomplete combustion of hydrocarbons has demonstrated the advantages of cost-effectiveness and production scalability over CNTs, and graphene and activates carbons in their synthesis [1-4]. However, candle soot-coated superhydrophobic materials are the best solution for these. The superhydrophobic surfaces on which water achieves a water contact angle higher than 150° and sliding angle less than 5° are attracting the minds of researchers due to their efficient oil-water separation abilities [5-8]. Different strategies used to form hierarchical structures such as sol-gel coating, chemical vapor deposition, plasma etching, template processing, lithographic patterning, etc. have been adopted [9-10].

Carbon soot (CS) generated from incomplete combustion of paraffin wax has demonstrated the advantages of cost-effectiveness and production scalability over carbon nanotubes (CNTs), graphene, and activated carbons in their synthesis. Hence, the carbon soot-coated superhydrophobic/superoleophilic surfaces show excellent oil-water separation ability compared to carbon nanotubes, carbon nanodots, and graphene [11].

Song et al. [12] have fabricated carbon soot (CS) coated mesh using the dip-coating method. The cleaned stainless-steel mesh (SSM) was subsequently dipped in the glue solution for 10 min and CS-dispersion, and finally dried at 80°C to obtain the CS-glue coated mesh. The CS coating is closely packed because of using superglue (EVO-STIK Serious Glue) as a binder. The CS-glue-coated mesh revealed a separation efficiency higher than 99.95%. Even after 20 cycle separation tests, it was shown excellent reusability and durability. The different chemical methods are used for the fabrication of the superhydrophobic/superoleophilic meshes/sponges for efficient oil-water separation. As the carbon nanotubes are hydrophobic and show a strong affinity toward oil, Lee et. al. [13] adopted the chemical vapor deposition (CVD) technique to deposit vertically aligned CNTs on stainless steel (SS) mesh. The as-prepared SS-CNT mesh effectively separates oil from water-in-oil emulsions with an efficiency higher than 80%. Gu et al. [14] prepared polystyrene (PS) and carbon nanotubes coated superhydrophobic/superoleophilic membranes. The as-prepared superhydrophobic/ superoleophilic membrane shows mechanically robust PS-CNT surface shows excellent oil separation from oil-water mixture with good repeatability and separation efficiency of more than 99%. The electrospinning technique can be effectively used to form superhydrophobic/superoleophilic surfaces. Wang et.al. [15] prepared the polyurethane (PU) sponge from hydrophilic to superhydrophobic by dip coating it from the nanocomposite of CNT/poly- (dimethyl siloxane) (PDMS). The as-prepared superhydrophobic/superoleophilic sponge shows the continuous removal of various oils such as Soybean oil, motor oil, diesel, n-hexadecane, gasoline, and n-hexane from the surface of the water with high separation efficiency.

In this article, we will discuss the simple, low-cost, rapid, and innovative methods for the fabrication of superhydrophobic/superoleophilic carbon soot nanoparticle-coated sponges and meshes for efficient oil-water separation application.

2. Recent Developments for Effective Oil-Water Separation:

2.1 Superhydrophobic-Superoleophilic Sponge:

Gao et al. obtained the candle soot (CS) particles from a combustion flame and dispersed them in 1,2-dichloroethane (DCE). The superhydrophobic/superoleophilic melamine sponge was prepared by a uniform coating of as-grown CS-DCE solution using the dip-coating method. The growth of carbon soot was performed using a combustion flame process in the open-air using ethylene (C_2H_4) and Oxygen (O_2) as precursors with a flow ratio of 5:3. The carbon soot sponge was prepared by dip-coating. First, 25 mg of as-grown carbon soot was dispersed in 20 mL for sonication. Then, a melamine sponge, which was cleaned with acetone and dried in an oven (80°C), was immersed in the carbon soot dispersion. The carbon soot-coated melamine was again dried in the oven at 80°C for 2 h **(Fig. 1).** The candle soot sponge demonstrates high absorption capacities (up to 80 times its weight) solvents with a recyclability of more than 10 times. These research results are promising in environmental remediation for large-scale, low-cost removal of oils from water [16].

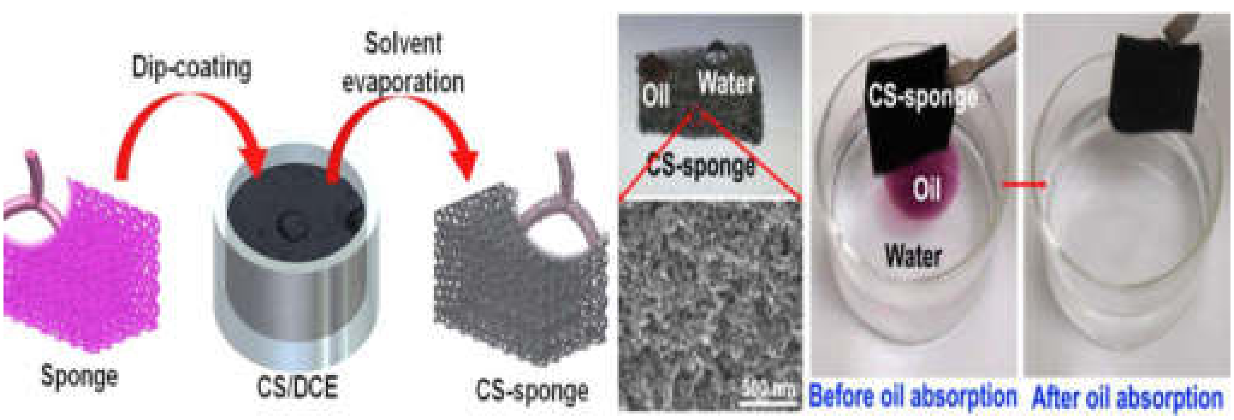

Fig. 1. Schematic showing the carbon soot-sponge preparation by dip-coating and carbon soot sponge before & after oil absorption. Photographs demonstrating the removal of an oil droplet from water using a CS-sponge [16], with permission from American Chemical Society, Copyright 2014.

A piece of commercial polyurethane sponge was cleaned and dried in an oven at 70°C for 30 min. The grown straw soot on the glass slide was collected by shaving soot from the glass using a spatula. The superhydrophobic sponge was prepared by a dip-coating method in a colloidal suspension of soot in an ethanol medium. The magnetic properties of the samples were detected at room temperature using a vibrating sample magnetometer. After that, the cleaned polyurethane sponge was dipped into the straw soot dispersion and dried; the hydrophobic sponge was obtained that floated on the water surface versus the non-modified sponge. The magnetic hydrophobic sponge was obtained by immersing the hydrophobic sponge in 20 mL of absolute ethanol containing magnetic nanoparticles **(Fig. 2).** The prepared sponge showed excellent superhydrophobicity with a water contact angle as high as 154°. Experiments showed that the amount of the absorbed oil was about more than 30 times of sponges' weight; it has 30 times recyclability and the advantage of magnetic separation [17].

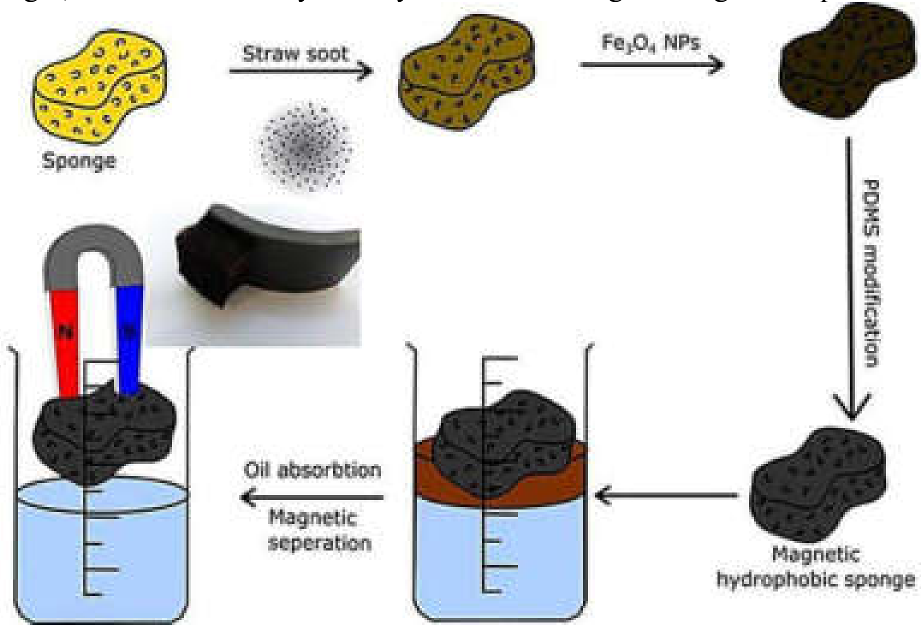

Fig. 2. Schematic illustration of preparation of modified polyurethane sponge and oil separation process. Images reprinted from [17], with permission from Elsevier, Copyright 2017.

Hydrophobic candle soot (CS) particles can be collected easily and cost-effectively from the candle flame. Li et al. [18] obtained the hydrophobic CS particles by incomplete combustion of hydrocarbons from the mid-candle flame. The polyurethane sponge was immersed in a mixture of CS, hydrophobic silica nanoparticles, and PU resin to achieve stable superhydrophobicity. The CS-SiO_2-PU sponge showed excellent oil separation capacity from hot water and acidic, alkaline, and salt solutions. The CS-SiO_2-PU sponges could absorb various oils efficiently and selectively, and show a high absorption capacity that is up to 65 times its weight. Furthermore, the CS-SiO_2-PU sponge possesses stable superhydrophobicity and excellent ability of selective absorption to oil even at various harsh conditions, including acid (1M HCl) and alkali (1M NaOH), and salt (1M NaCl) aqueous solutions at mechanical agitation condition, hot water, and ice/water mixtures. The CS-SiO_2-PU sponge combination with a vacuum system could continuously absorb and remove oil from the water surface. As shown in **(Fig. 3a),** the contact angle of a colored water droplet on the PU sponge is nearly 100° and the colored kerosene droplet contact angle is about 0°. However, the CS-SiO_2-PU sponge shows superhydrophobicity and superoleophobicity simultaneously **(Fig. 3b)**. The kerosene droplet was absorbed by the CS-SiO_2-PU sponge immediately when it was dropped on the surface of the sponge, while the water droplet stayed on the surface of the as-prepared sponge and kept its spherical shape. As shown in **(Fig. 3c and d),** the water contact angle on the CS-SiO_2-PU sponge is up to 155° and the SA is as low as 7°. Therefore, the water was repelled by the as-prepared sponge, whereas the oil absorbed through the sponge quickly.

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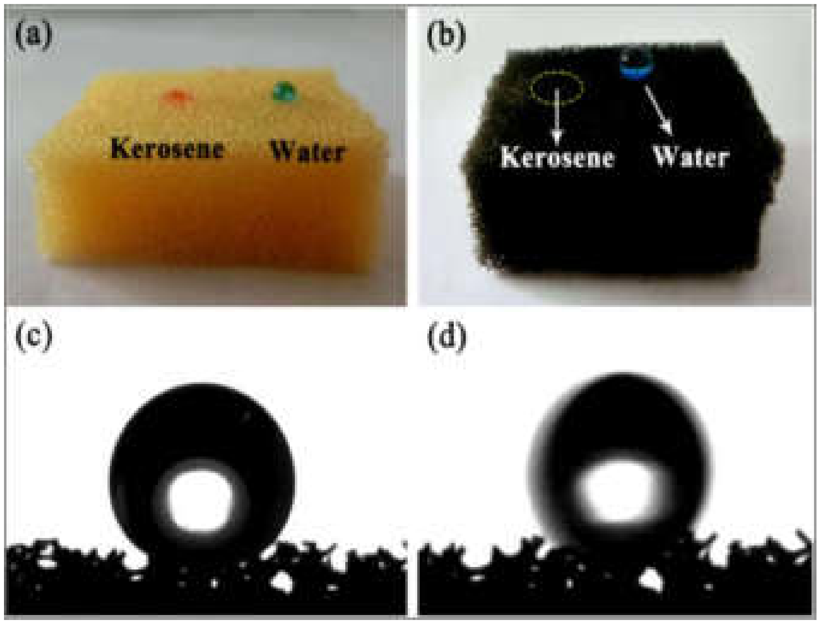

Fig. 3. (a and b) Schematic illustration of the fabrication of the wettability of the pristine PU sponge and the CS-SiO_2-PU sponge to water and oil droplets, respectively. (c and d) The CA and SA of water on the CS-SiO_2-PU sponge, respectively [18], with permission from J. Sol-Gel Sci Technol., Copyright 2017.

Yue et al. fabricated the superhydrophobic surface using PVDF and candle soot via the sugar template method. It was shown the water contact angle of 158° and roll-on angle of < 6°. The oil quickly absorbed by the superhydrophobic sponge shows the superoleophilic property. The sponge shows excellent oil-water separation properties even after 25 cycles. The strong elasticity and high stretching resistance confirm that the modified superhydrophobic surface is highly mechanically durable. The modified sponge maintains an 89% recovery rate even after 10 cycles. The absorption capability recovered up to 96% without an obvious change in the morphology of the sponge surface. This method was used to prepare a photothermal, porous PVDF/CS sponge with structural, chemical, and mechanical properties [19]. **Fig. 4** shows the preparation process of the porous PVDF/candle soot sponge. In short, sugar particles were placed into a PVDF/DMF/CS solution mixture, followed by sugar templates being removed via water dissolving. It is important to note that a simple sugar-templating process was used for the formation of a superhydrophobic sponge, it requires only a simple as well as eco-friendly preparation process.

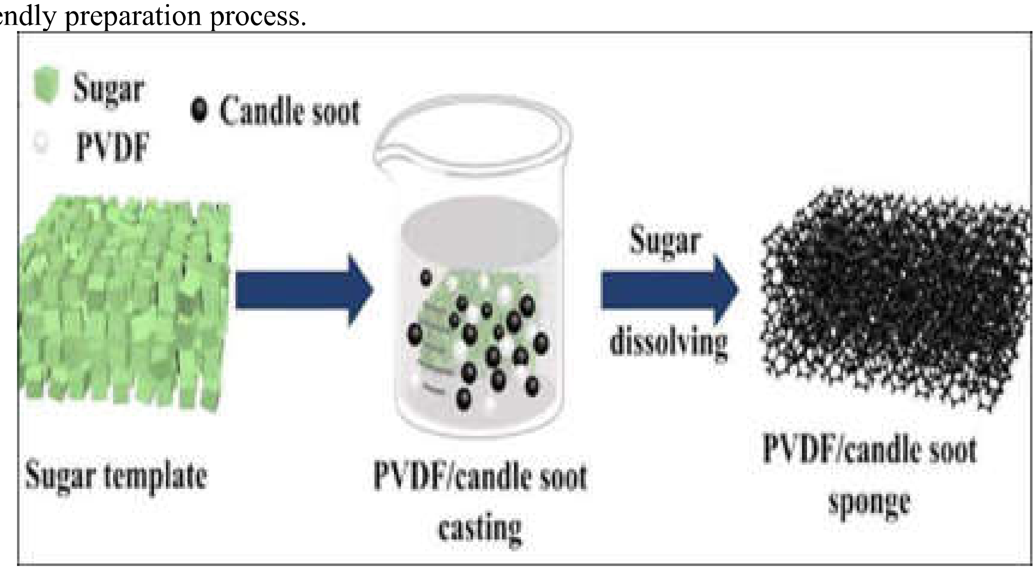

Fig. 4. Schematic illustration of the fabrication of porous PVDF/candle soot sponge using sugar template. Images reprinted from [19], with permission from Elsevier, Copyright 2021.

2.2 Superhydrophobic/Superoleophilic Mesh:

Li et. al. [20] deposited hydrophobic CS particles on a SS mesh by holding it in the mid-flame of a paraffin candle and then spray-coated the hydrophobic silica nanoparticles (50 nm) on it. The as-prepared carbon soot/silica nanoparticles (CS/SiO_2) hybrid mesh revealed strong repellence toward pure water and droplets of pH ranging from 1 to 14, whereas the oil drops quickly spread on the surface. The hybrid mesh revealed the strong ability to separate various oils and organic liquids mixed in pure water, hot water (92°C), and strong corrosive solutions (1M HCl, NaOH, and NaCl) with more than 98% separation efficiency. The oil/water separation was performed as shown in Fig. 5. Because of the excellent mechanical flexibility of the stainless-steel mesh, the mesh was folded into a three-dimensional structure and then coated with CS and hydrophobic silica for oil/water separation. The coated mesh was placed on a beaker and a mixture of kerosene and water was poured onto the three-dimensional superhydrophobic mesh, as shown in **Fig. 5 (a-c)**. Kerosene was dropped into the beaker, while water was repelled and retained above the mesh. **Fig. 5d** exhibited that there are no oily droplets were present in the water. After the separation, a nearly equal amount of water and kerosene were collected, which suggested the extremely high separation efficiency of the coated mesh as shown in **Fig. 5e**.

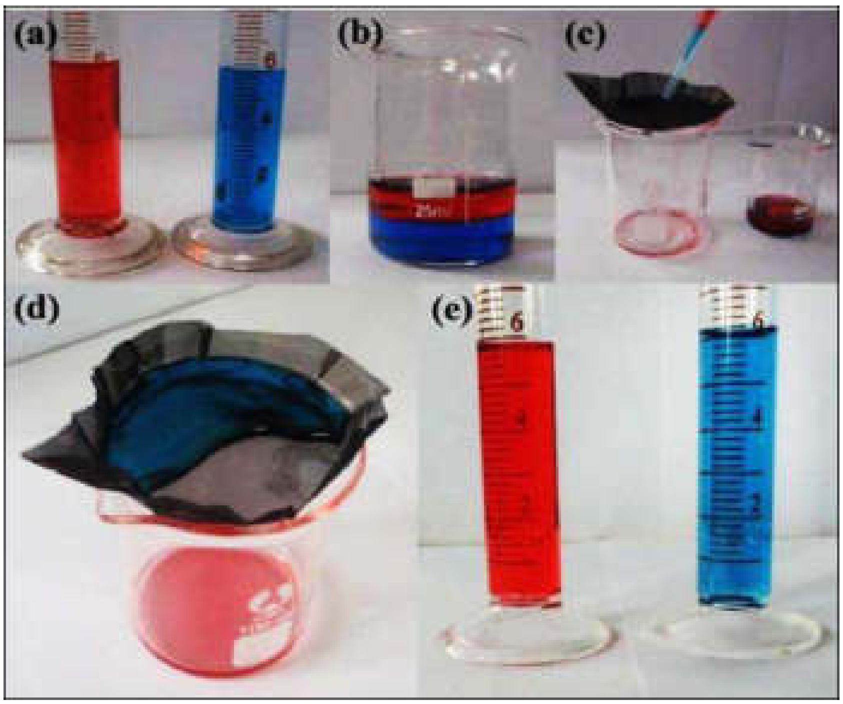

Fig. 5. Schematic illustration of the separation process of oil (kerosene)/water mixture based on the CS and silica overlap coated mesh. (a-b) water is dyed with methylene blue and oil is dyed with Oil Red O and then they are mixed before separation. (c-d) the separation process of the oil/water mixture using the overlap-coated mesh. (e) The water and oil volume remained nearly the same after separation [20], with permission from RSC Nanoscale, Copyright 2016.

Cao et al. [21] used the electrodeposition technique for the formation of superhydrophobic/superoleophilic copper meshes and then held it above candle flame to deposit carbon soot (CS) nanoparticles. The agglomerated CS nanoparticles formed a chain-like rough hierarchical structure on which the water drop exhibited a contact angle higher than 153°. The CS deposited copper mesh quickly separated various oils such as silicone oil, cyclohexane, n-hexane, n-heptane, petroleum ether, and liquid paraffin from oil-water mixtures with oil separation efficiency greater than 90% even after 30 separation cycles. The rough mesh was placed at 1.5 cm height of the flame of a burning candle for deposition for 5 minutes, the whole preparation process is shown in the **Fig. 6,** the superhydrophobic mesh surface was formed by using candle soot.

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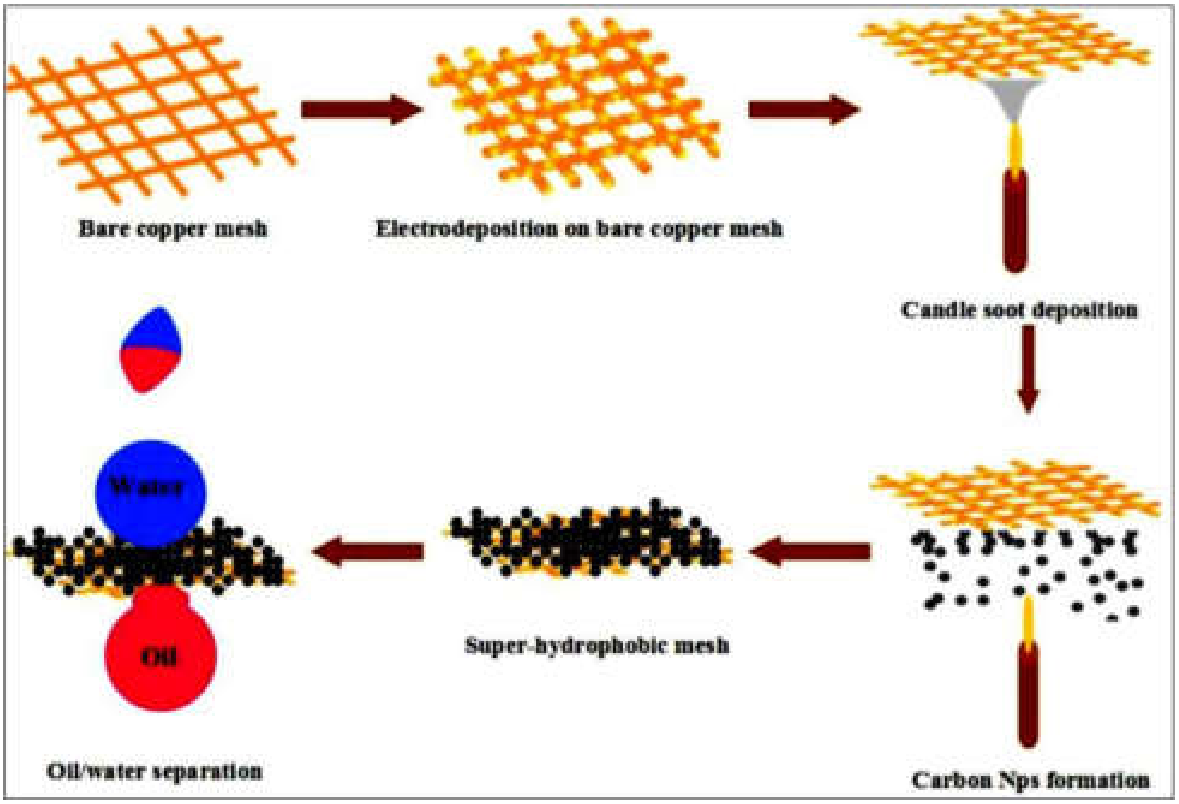

Fig. 6. Schematic illustration of the preparation process of super-hydrophobic and super-oleophilic copper mesh, and the application in oil-water separation [21], with permission from Colloids and Surfaces A: Physicochem. Eng. Aspects, Copyright 2017.

Zulfiqar et al. [22] deposited cheaply available sawdust on polychloroprene adhesive-coated SS mesh with subsequent deposition of silicone polymer by dip coating. Thereafter, a thin layer of CS particles was applied to the as-prepared mesh by holding it above a candle flame. The carbon soot (CS) nanoparticles uniformly deposited on silicone-covered SD exhibited highly rough and porous morphology required for superhydrophobicity and superoleophobicity. As depicted in **Fig. 7**, a superhydrophobic SS mesh easily and rapidly separates the oil-water mixture. No trace of water was observed in separated oil confirming its potential in oil-water separation capability. Apart from excellent oil-water separation efficiency (>95%), the superhydrophobic SS mesh exhibited good recyclability, reusability, and mechanical stability. The potential of these coatings for oil/water separation is shown in **Fig. 7**. The figure typically shows a mesh coated with superhydrophobic material holding water without any leakage. The superhydrophobic mesh was used for the separation of oil from oil-water mixtures as shown in **Fig. 7**. The mesh readily separated the oil while blocking the flow of water through its pores. The water content was not found in the separated oil, which confirms the excellent superhydrophobic/superoleophilic properties. The steel mesh with excellent mechanical stability modified with durable superhydrophobic coating can be used as a medium for oil/water separation.

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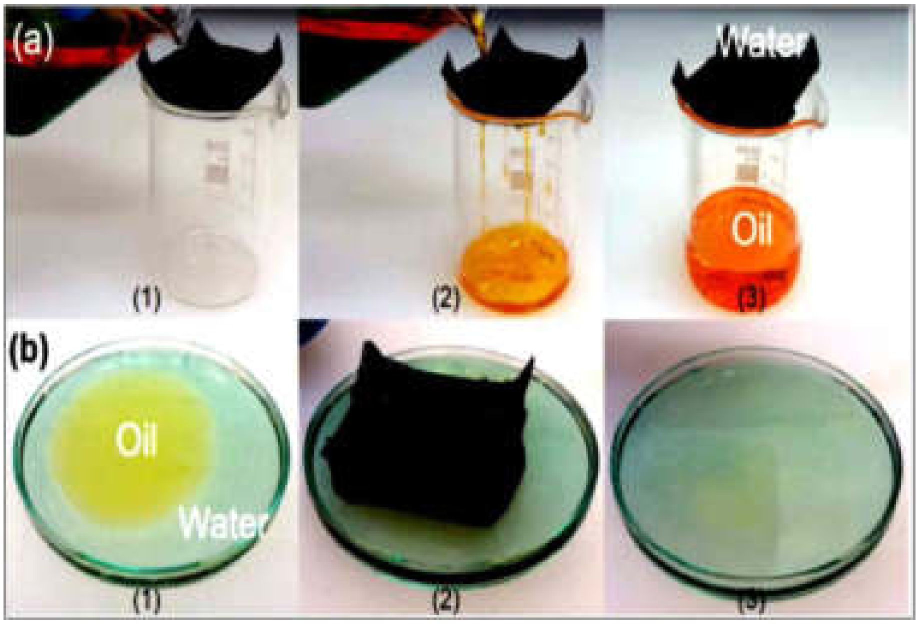

Fig. 7. Schematic illustration of a superhydrophobic mesh demonstrating (a) the separation of oil/water mixture and (b) collection of oil from oil/water mixture [22], with permission from Colloids and Surfaces A: Physicochem. Eng. Aspects, Copyright 2017.

To achieve a robust, transparent, and superhydrophobic coating, the substrate was first thoroughly washed with ethanol and deionized water thoroughly and dried in an oven at 60°C. The cleaned substrate was then placed over the candle flame until a few microns thick layer of soot was deposited. Subsequently, the soot-coated substrate together with $SiCl_4$ was placed in a drier for chemical vapor deposition for about 2 h. Finally, a superhydrophobic coating was obtained on the substrate caused by stable oxane bonds formed between abundant hydroxyl radicals on the silica shell and silane. Furthermore, to investigate the oil-water separation application of this transparent, robust, and superhydrophobic coating, a rounded stainless-steel mesh was utilized as a substrate to perform the modification **(Fig. 8)**. The rough surface formed by accumulating candle soot nanoparticles showed a significant superhydrophobicity with a water contact angle of 154.4° and it remained good oil flow rate and oil-water separation efficiency even after 6 times reuses [23].

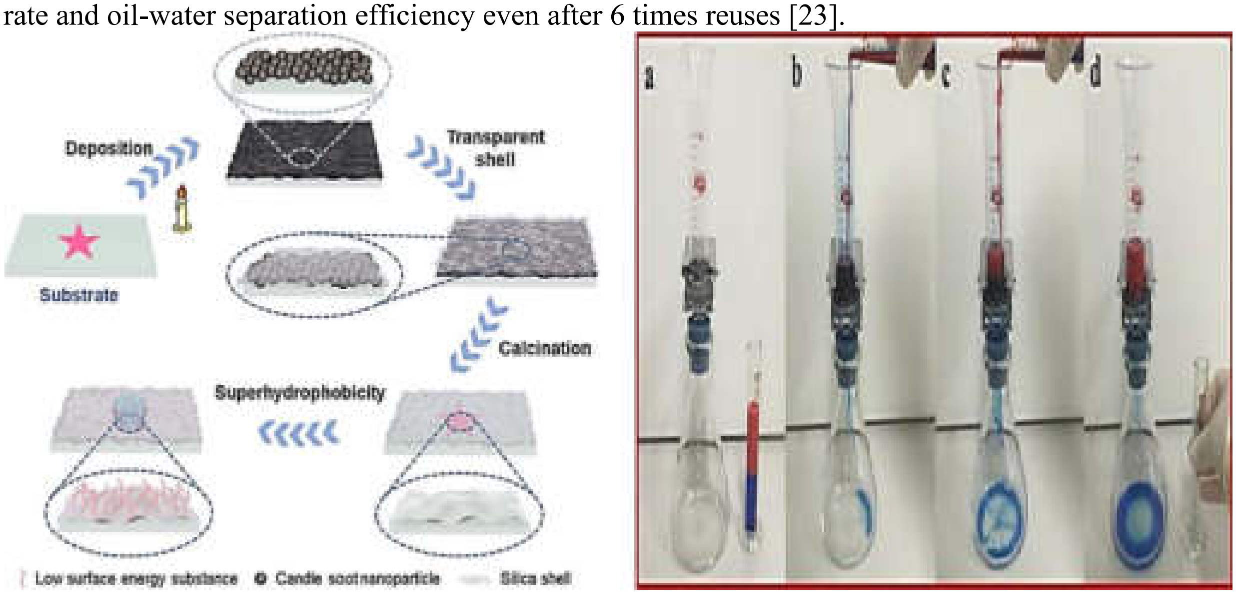

Fig. 8. Schematic of preparation and properties of the transparent and robust superhydrophobic coating and oil–water separation. Images reprinted from [23], with permission from Nature, Copyright 2022.

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The stainless-steel mesh was ultrasonically cleaned using acetone, ethanol, and deionized water for 5 min, respectively, and then dried in a blast oven at 80°C for 10 min. Then, it was put on the candle flame with a height of 1.5 cm to collect candle soot and the whole process continued for 15 seconds. Then, the prepared sample was immersed in PDMS and xylene solution of 1.5 g PDMS dissolved in 50 mL xylene. Then, the mesh was placed in a blast oven at 80°C for 10 min. Secondly, repeat the collection process of candle soot and then put it in a blast oven at 80°C for 120 min. The as-prepared mesh was named SH-M and the schematic for the preparation process is shown in **Fig. 9.** The SH-M can show a highly superhydrophobic surface such as a water contact angle is 156° and a sliding angle of less than 5° [24].

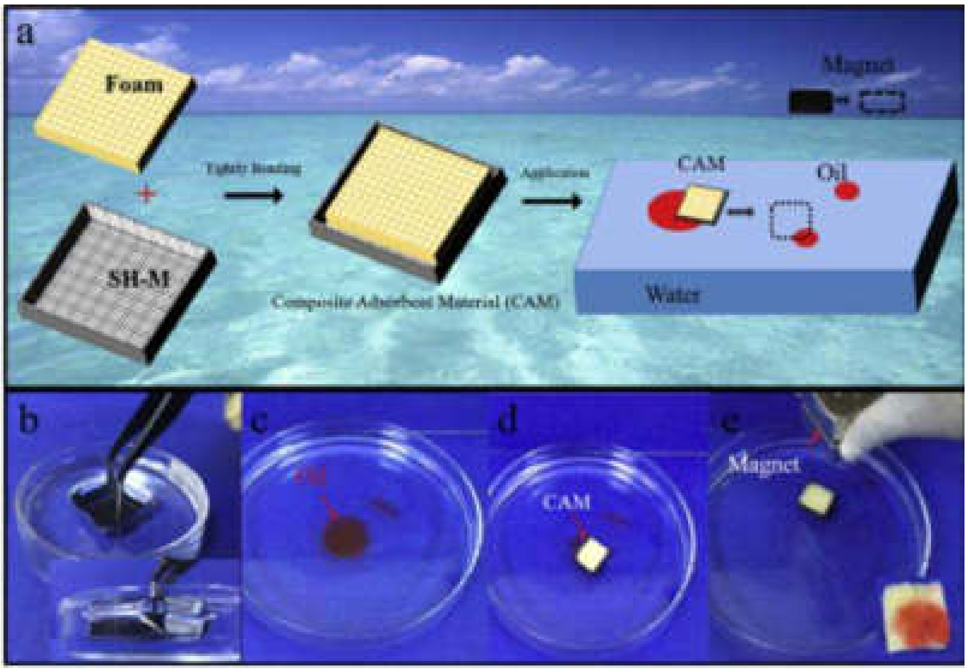

Fig. 9. (a) Schematic for the preparation process of composite adsorbent material (CAM) from the SH-M square boat and polymer foam, as well as its application of magnet drive for oil/water separation; (b) SH-M square boat immersion in water by force; (c–e) picture of the magnet drive CAM oil adsorption process [24], with permission from Progress in Organic Coatings, Copyright 2019.

A stainless-steel mesh was placed above the wick and soot was collected on the surface. The 10 nm carbon nanoparticles were coated onto the stainless-steel mesh. Then, we used a chemical vapor deposition method to form a more stable layer of SiO_2/carbon on the stainless-steel mesh. Finally, the SiO_2/carbon stainless steel mesh was modified with PFO and PDA-PFO, respectively to form the superhydrophobic/superoleophobic and oleophobic/superhydrophilic mesh membrane **(Fig. 10).** Separation experiments show that these superhydrophobic/superoleophobic or oleophobic/superhydrophilic mesh membranes can be used to selectively separate oil-water with a high flux of more than 930 L m^{-2} h^{-1} and a collecting efficiency of over 97%. Furthermore, the repetitions of the separation experiments demonstrate that these superhydrophobic/superoleophilic or oleophobic/superhydrophilic mesh membranes are durable, stable, and reusable, making them encouraging candidates for practical oil-polluted water treatment [25].

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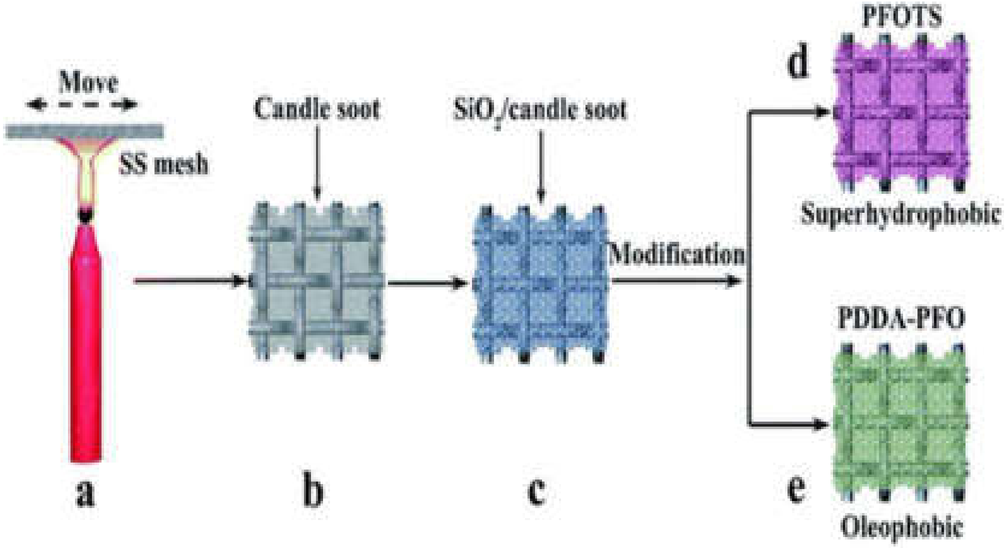

Fig. 10. Process of superhydrophobic and oleophobic mesh membranes preparation: (a) coating stainless steel mesh with carbon nanoparticle (candle soot), (b) carbon nanoparticle coated stainless steel mesh, (c) SiO_2/carbon stainless steel mesh, (d) PFOTS modified SiO_2/carbon stainless steel mesh, (e) PDDA–PFO modified SiO_2/carbon stainless steel mesh [25], with permission from RSC Adv., Copyright 2017.

Mesh prepared with a PFCS coating can be used to separate oil. After cutting a piece of iron mesh and coating the mesh with paraffin wax, a metal sheet was patched onto the back of the mesh with sot from a candle flame a superhydrophobic mesh coating is oleophilic, and a water drop cannot penetrate through the mesh, but Polydimethylsiloxane (PDMS) oil can as be shown in Fig. 8, shows a side view of the drops. While the water drop remains on the mesh, the PDMS oil drop with a low surface tension passes through the mesh and dongles from the mesh. The mixture of water and PDMS oil was easily separated with the mesh. This mesh can be effective in oil collection systems and functional filtration systems [26].

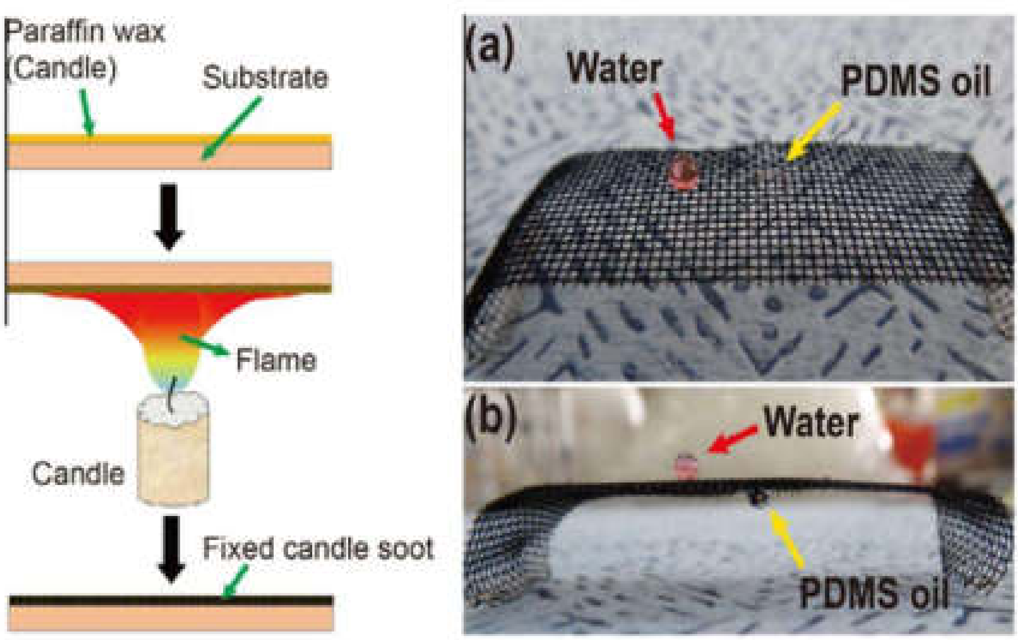

Fig. 11. A scheme for the fabrication of a stable superhydrophobic surface by using only a candle and a superhydrophobic mesh prepared with a PFCS coating [26], with permission from Carbon, Copyright 2014.

2.3 Superhydrophobic/Superoleophilic Foam:

The superhydrophobic and superoleophilic surface was fabricated by candle soot coating and sequential modification with PDMS. Nickel foam was cleaned by alternate ultra-sonication in ethanol and Milli-Q water three times and then dried in the oven. Afterward, the surface to be coated, in our case a nickel foam, is held above the flame of a paraffin candle. About 5 min. After the ignition of the candle, a steady flame was obtained with a total flame height of 4 cm. Ni foam (5 cm × 5 cm) was mounted in the flame envelope 3.5 cm above the candle. The growth process lasted for 2 min for the one side and then for another 2 min for the other side with Ni foam moving back and forth, after which the Ni foam was taken out from the flame. Deposition of a soot layer turns the nickel foam black. The candle soot-coated nickel foam was placed into a petri dish in which a mixture of hexane, PDMS pre-polymer, and thermal curing agent was poured in a ratio of 100:10:1 by weight. The candle soot-coated nickel foam with the absorbed mixture was then cured at 80°C for 4 hours as shown in **Fig. 12.** The prepared nickel foam showed excellent superhydrophobicity with a water contact angle as high as 152°. These research results show evidence that the coating of candle soot can be applied to a wide variety of heat-resistant surfaces and is effective for the separation of water and oil mixture [27].

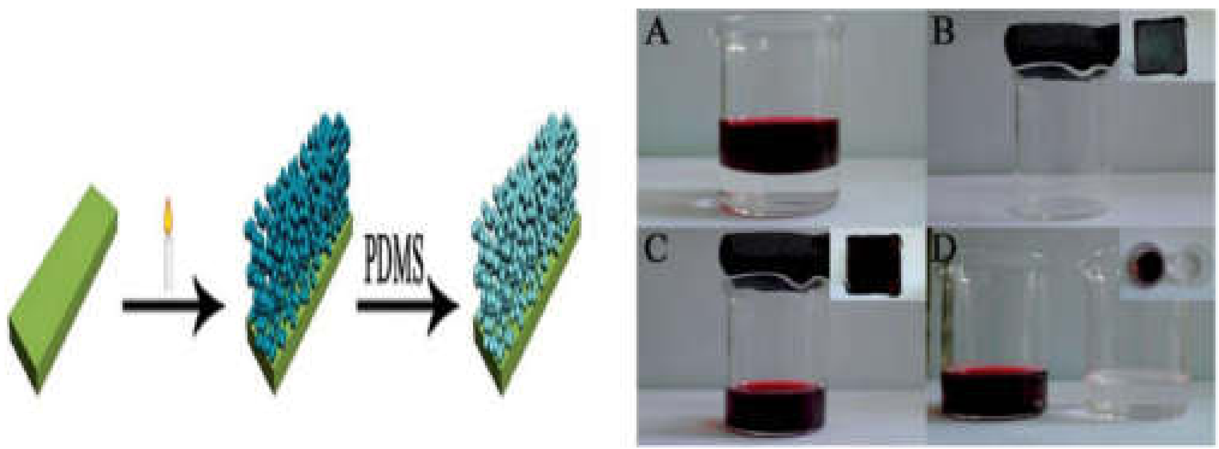

Fig. 12. Preparing superhydrophobic and superoleophilic nickel foam and Experiment process images of the water purification using superhydrophobic and superoleophilic nickel foam [27], with permission from RSC Adv., Copyright 2014.

The Nickel foam was cut into several small pieces of 3 cm × 3 cm and then placed in an ultrasonic cleaner with ethanol for 30 min washed with deionized water 3 times and dried in an oven at 60°C. The stable suspension liquid was obtained by adding 0.1 g CNPs, 1 g PDMS, and 0.1 g curing agent to 50 mL n-hexane, and then ultrasonic treatment at 30 kHz for 1 h. The clean and dried Ni foam chips are immersed in the above suspension and left at ambient temperature until the solvent evaporates to dryness, afterwards, the mixture of CNPs and PDMS is uniformly deposited on the inside and surface of the Ni foam. Then, place it in a muffle furnace at 100°C for 1 h. to make it solidify. Finally, five of the above prepared small pieces were pressed into the NF/CNP-PDMS with a size of 3 cm × 3 cm × 2 mm by pressing the machine **(Fig. 13)**. It can show superhydrophobic properties with a WCA of 153° and an oil contact angle of nearly 0°. It shows the substrate is superhydrophobic and easily separates the oil from water [28].

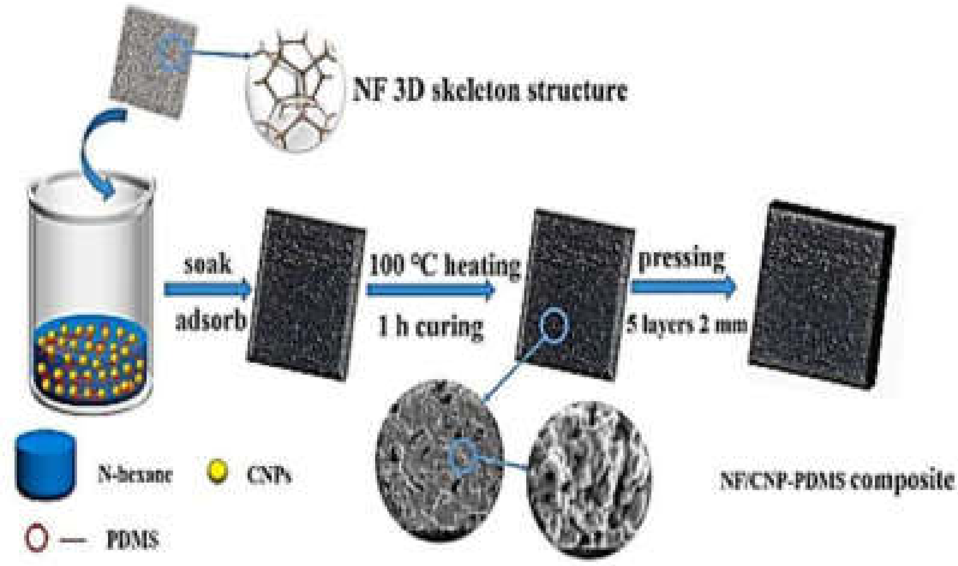

Fig. 13. Schematic diagram of NF/CNP-PDMS composite preparation [28], with permission from Colloids and Surfaces A: Physicochem. and Eng. Aspects, Copyright 2021.

The fabrication process is firstly, CNTs were dispersed in THF by sonication for 30 min. Then, PS (Polystyrene) and CA (Cinnamic Acid) were dissolved in the CNTs-THF dispersion. The mixture was stirred for 2 h and sonicated for 30 min to reach homogeneity. Subsequently, distilled water was poured into the suspension to induce phase inversion and form the PS/CNTs/CA foam. The foam was dried and then immersed in isopropyl alcohol for 3 h to remove the CA. The PS/CNTs foam was obtained after drying. For comparison the pure PS foam was fabricated by the same two-step strategy **(Fig. 14).** It can show a water contact angle of 161.2° and excellent water repellence, with great application potential in the treatment of oil spills [29].

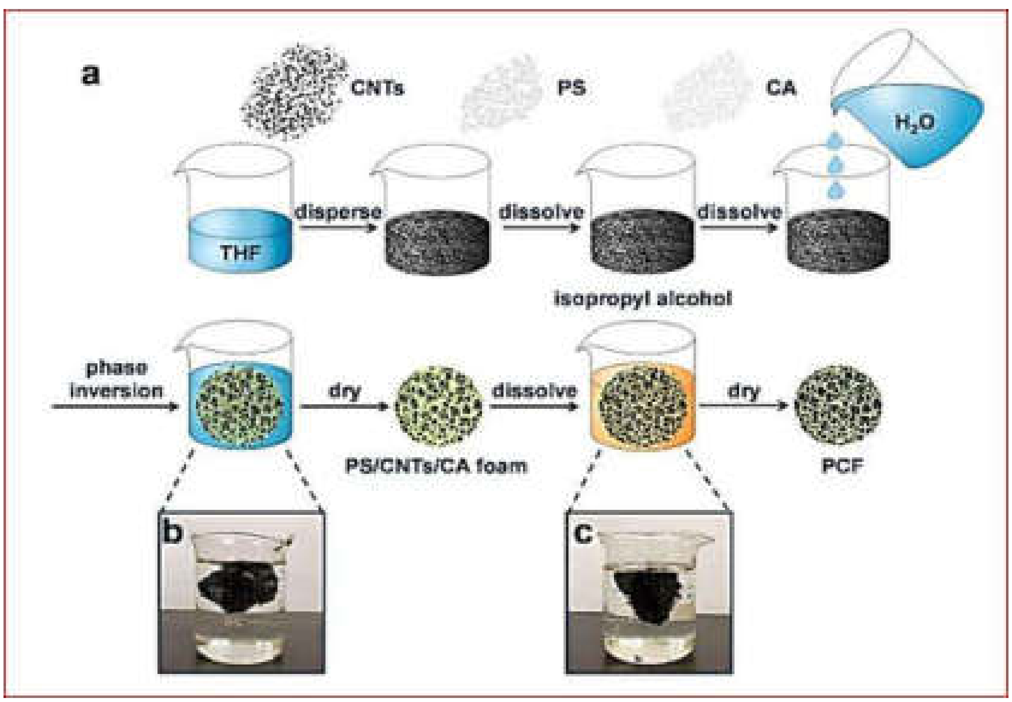

Fig. 14. (a) Schematic illustration of the fabrication process of the PCF; (b) photograph of the PS/CNTs/CA foam in water; (c) photograph of the PCF in isopropyl alcohol [29], with permission from J. Env. Chem. Eng., Copyright 2021.

Conclusion:

As this review highlights, candle soot nanoparticles are unique in that, their fabrication requires little control of external parameters. It is very economical beneficial, facile, and straightforward to synthesize. Candle soot-coated sponge/mesh for use in oil-water separation has been developed by using CS nanoparticles and different polymers. The candle soot synthesis, candle soot coated sponge/mesh preparation, procedures are simple, cost-effective, and scalable. The absorption/separation investigation demonstrates that the candle soot sponge/mesh is highly efficient and stable in absorbing a wide range of oil and organic solvents. It can be believed that the candle-soot-coated superhydrophobic materials are very useful for oil-water separation. It shows various tremendous results with candle soot-polymer composite in various mechanical conditions. Candle soot nanoparticles show a significant surface area-to-volume ratio and high electronic and ionic conductivity. Candle soot is produced by simply burning candles and hence, it is eco-friendly, economical, and useful. Candle soot-coated sponge/mesh can show stability, durability, reusability, and reproducibility.

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INDEX

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Chapter No. 15

Candle Soot Modified Superhydrophobic/ Superoleophilic Surfaces for Oil-Water Separation: A review

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Abstract-

Over many years, the oceanic oil spill accidents and the discharging of immense oil levels in the surroundings of most industries worldwide have been a serious environmental problem. Oil and organic pollutants in water has a severe problem for aquatic life and human being. There is a need to develop technology for oil-water separation because the spilled oil affects the ecological and environmental system. Recently, superhydrophobic/superoleophilic sponges, metal meshes, membranes, and porous materials have played crucial roles in separating oil from oil-water mixture. The micro and nanopores of the substrate facilitate to entry of liquid into it and superhydrophobic/superoleophilic properties of the substrate surface resist water and allow oil to enter into the porous substrate. Candle soot has the advantages of cost-effectiveness and production scalability over other carbons like graphene, carbon nanotubes, carbon nanodots, etc. in their synthesis. Candle soot-coated superhydrophobic materials have outstanding water repulsion and oil absorption capacity, high selectivity, chemical inertness, and excellent recyclability. This paper discusses applications of candle soot-coated superhydrophobic materials for oil-water separation.

Keywords: *Candle soot, oil-water separation, sponge, stainless steel mesh, and superhydrophobic.*

Introduction-

During the past few years, water pollution resulting from oil spillage and industrial organic pollutants has emerged as a serious issue on a global scale, imposing threats to the ecosystem, human health, and economic growth. To overcome this challenge, many efforts have been made to develop efficient absorbents such as activated candle soot nanoparticles, carbon nanotube sponges, carbon nanodots sponges, candle soot/polymer composites, and graphene sponges for separating and removing the contaminants from water. Among all these absorbents, candle-soot-based absorbents demonstrate superior efficiency in the removal of oils. However, the high production costs of these absorbents limit their wide adoption. Candle soot generated from incomplete combustion of hydrocarbons has demonstrated the advantages of cost-effectiveness and production scalability over CNTs, and graphene and activates carbons in their synthesis [1-4]. However, candle soot-coated superhydrophobic materials are the best solution for these. The superhydrophobic surfaces on which water achieves a water contact angle higher than 150° and sliding angle less than 5° are attracting the minds of researchers due to their efficient oil-water separation abilities [5-8]. Different strategies used to form hierarchical structures such as sol-gel coating, chemical vapor deposition, plasma etching, template processing, lithographic patterning, etc. have been adopted [9-10].

Carbon soot (CS) generated from incomplete combustion of paraffin wax has demonstrated the advantages of cost-effectiveness and production scalability over carbon nanotubes (CNTs), graphene, and activated carbons in their synthesis. Hence, the carbon soot-coated superhydrophobic/superoleophilic surfaces show excellent oil-water separation ability compared to carbon nanotubes, carbon nanodots, and graphene [11].

Song et al. [12] have fabricated carbon soot (CS) coated mesh using the dip-coating method. The cleaned stainless-steel mesh (SSM) was subsequently dipped in the glue solution for 10 min and CS-dispersion, and finally dried at 80°C to obtain the CS-glue coated mesh. The CS coating is closely packed because of using superglue (EVO-STIK Serious Glue) as a binder. The CS-glue-coated mesh revealed a separation efficiency higher than 99.95%. Even after 20 cycle separation tests, it was shown excellent reusability and durability. The different chemical methods are used for the fabrication of the superhydrophobic/superoleophilic meshes/sponges for efficient oil-water separation. As the carbon nanotubes are hydrophobic and show a strong affinity toward oil, Lee et. al. [13] adopted the chemical vapor deposition (CVD) technique to deposit vertically aligned CNTs on stainless steel (SS) mesh. The as-prepared SS-CNT mesh effectively separates oil from water-in-oil emulsions with an efficiency higher than 80%. Gu et al. [14] prepared polystyrene (PS) and carbon nanotubes coated superhydrophobic/superoleophilic membranes. The as-prepared superhydrophobic/ superoleophilic membrane shows mechanically robust PS-CNT surface shows excellent oil separation from oil-water mixture with good repeatability and separation efficiency of more than 99%. The electrospinning technique can be effectively used to form superhydrophobic/superoleophilic surfaces. Wang et.al. [15] prepared the polyurethane (PU) sponge from hydrophilic to superhydrophobic by dip coating it from the nanocomposite of CNT/poly- (dimethyl siloxane) (PDMS). The as-prepared superhydrophobic/superoleophilic sponge shows the continuous removal of various oils such as Soybean oil, motor oil, diesel, n-hexadecane, gasoline, and n-hexane from the surface of the water with high separation efficiency.

In this article, we will discuss the simple, low-cost, rapid, and innovative methods for the fabrication of superhydrophobic/superoleophilic carbon soot nanoparticle-coated sponges and meshes for efficient oil-water separation application.

2. Recent Developments for Effective Oil-Water Separation:

2.1 Superhydrophobic-Superoleophilic Sponge:

Gao et al. obtained the candle soot (CS) particles from a combustion flame and dispersed them in 1,2-dichloroethane (DCE). The superhydrophobic/superoleophilic melamine sponge was prepared by a uniform coating of as-grown CS-DCE solution using the dip-coating method. The growth of carbon soot was performed using a combustion flame process in the open-air using ethylene (C_2H_4) and Oxygen (O_2) as precursors with a flow ratio of 5:3. The carbon soot sponge was prepared by dip-coating. First, 25 mg of as-grown carbon soot was dispersed in 20 mL for sonication. Then, a melamine sponge, which was cleaned with acetone and dried in an oven (80°C), was immersed in the carbon soot dispersion. The carbon soot-coated melamine was again dried in the oven at 80°C for 2 h **(Fig. 1).** The candle soot sponge demonstrates high absorption capacities (up to 80 times its weight) solvents with a recyclability of more than 10 times. These research results are promising in environmental remediation for large-scale, low-cost removal of oils from water [16].

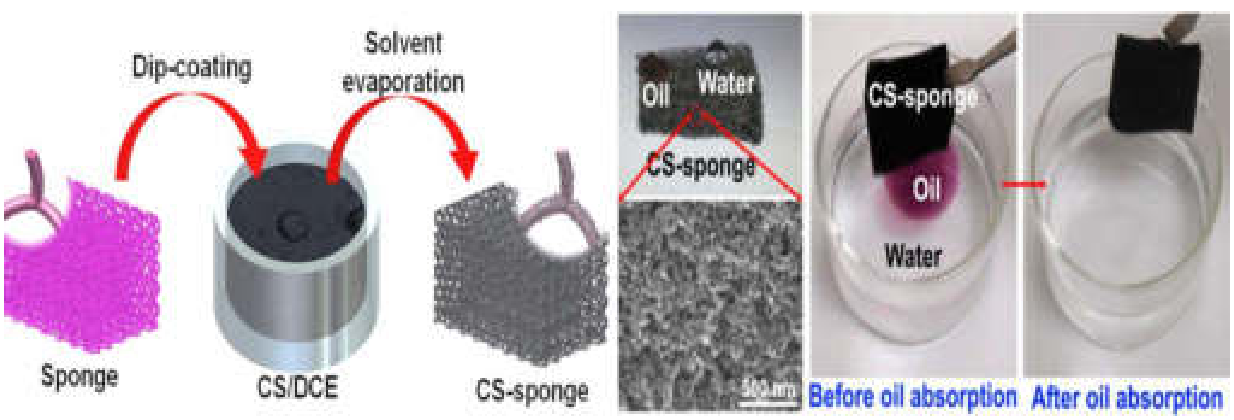

Fig. 1. Schematic showing the carbon soot-sponge preparation by dip-coating and carbon soot sponge before & after oil absorption. Photographs demonstrating the removal of an oil droplet from water using a CS-sponge [16], with permission from American Chemical Society, Copyright 2014.

A piece of commercial polyurethane sponge was cleaned and dried in an oven at 70°C for 30 min. The grown straw soot on the glass slide was collected by shaving soot from the glass using a spatula. The superhydrophobic sponge was prepared by a dip-coating method in a colloidal suspension of soot in an ethanol medium. The magnetic properties of the samples were detected at room temperature using a vibrating sample magnetometer. After that, the cleaned polyurethane sponge was dipped into the straw soot dispersion and dried; the hydrophobic sponge was obtained that floated on the water surface versus the non-modified sponge. The magnetic hydrophobic sponge was obtained by immersing the hydrophobic sponge in 20 mL of absolute ethanol containing magnetic nanoparticles **(Fig. 2).** The prepared sponge showed excellent superhydrophobicity with a water contact angle as high as 154°. Experiments showed that the amount of the absorbed oil was about more than 30 times of sponges' weight; it has 30 times recyclability and the advantage of magnetic separation [17].

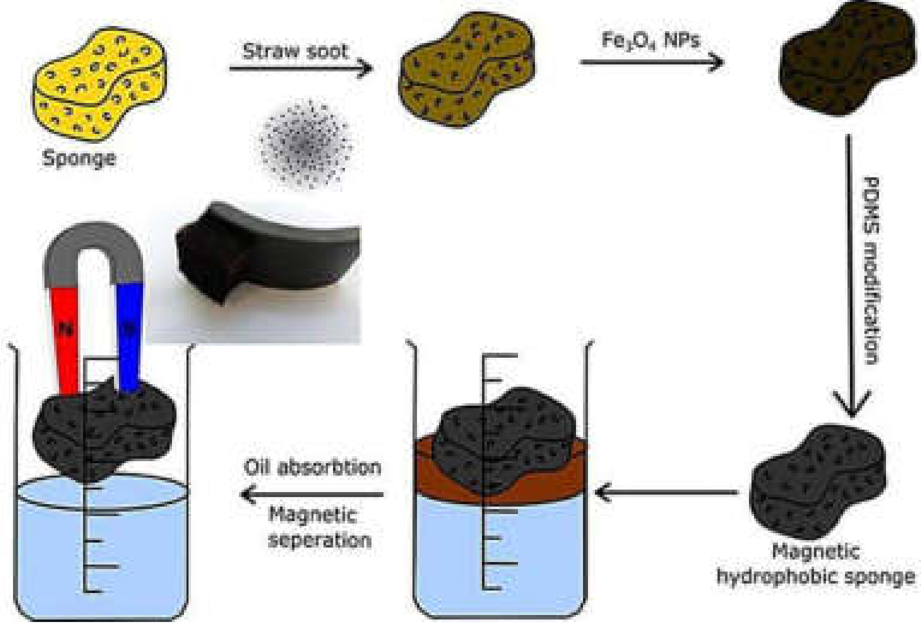

Fig. 2. Schematic illustration of preparation of modified polyurethane sponge and oil separation process. Images reprinted from [17], with permission from Elsevier, Copyright 2017.

Hydrophobic candle soot (CS) particles can be collected easily and cost-effectively from the candle flame. Li et al. [18] obtained the hydrophobic CS particles by incomplete combustion of hydrocarbons from the mid-candle flame. The polyurethane sponge was immersed in a mixture of CS, hydrophobic silica nanoparticles, and PU resin to achieve stable superhydrophobicity. The CS-SiO_2-PU sponge showed excellent oil separation capacity from hot water and acidic, alkaline, and salt solutions. The CS-SiO_2-PU sponges could absorb various oils efficiently and selectively, and show a high absorption capacity that is up to 65 times its weight. Furthermore, the CS-SiO_2-PU sponge possesses stable superhydrophobicity and excellent ability of selective absorption to oil even at various harsh conditions, including acid (1M HCl) and alkali (1M NaOH), and salt (1M NaCl) aqueous solutions at mechanical agitation condition, hot water, and ice/water mixtures. The CS-SiO_2-PU sponge combination with a vacuum system could continuously absorb and remove oil from the water surface. As shown in **(Fig. 3a),** the contact angle of a colored water droplet on the PU sponge is nearly 100° and the colored kerosene droplet contact angle is about 0°. However, the CS-SiO_2-PU sponge shows superhydrophobicity and superoleophobicity simultaneously **(Fig. 3b)**. The kerosene droplet was absorbed by the CS-SiO_2-PU sponge immediately when it was dropped on the surface of the sponge, while the water droplet stayed on the surface of the as-prepared sponge and kept its spherical shape. As shown in **(Fig. 3c and d),** the water contact angle on the CS-SiO_2-PU sponge is up to 155° and the SA is as low as 7°. Therefore, the water was repelled by the as-prepared sponge, whereas the oil absorbed through the sponge quickly.

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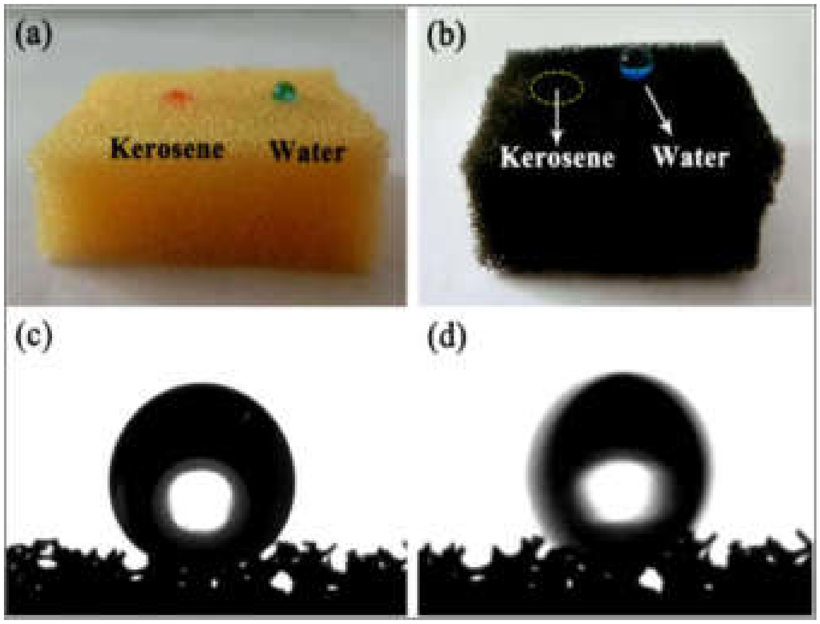

Fig. 3. (a and b) Schematic illustration of the fabrication of the wettability of the pristine PU sponge and the CS-SiO_2-PU sponge to water and oil droplets, respectively. (c and d) The CA and SA of water on the CS-SiO_2-PU sponge, respectively [18], with permission from J. Sol-Gel Sci Technol., Copyright 2017.

Yue et al. fabricated the superhydrophobic surface using PVDF and candle soot via the sugar template method. It was shown the water contact angle of 158° and roll-on angle of < 6°. The oil quickly absorbed by the superhydrophobic sponge shows the superoleophilic property. The sponge shows excellent oil-water separation properties even after 25 cycles. The strong elasticity and high stretching resistance confirm that the modified superhydrophobic surface is highly mechanically durable. The modified sponge maintains an 89% recovery rate even after 10 cycles. The absorption capability recovered up to 96% without an obvious change in the morphology of the sponge surface. This method was used to prepare a photothermal, porous PVDF/CS sponge with structural, chemical, and mechanical properties [19]. **Fig. 4** shows the preparation process of the porous PVDF/candle soot sponge. In short, sugar particles were placed into a PVDF/DMF/CS solution mixture, followed by sugar templates being removed via water dissolving. It is important to note that a simple sugar-templating process was used for the formation of a superhydrophobic sponge, it requires only a simple as well as eco-friendly preparation process.

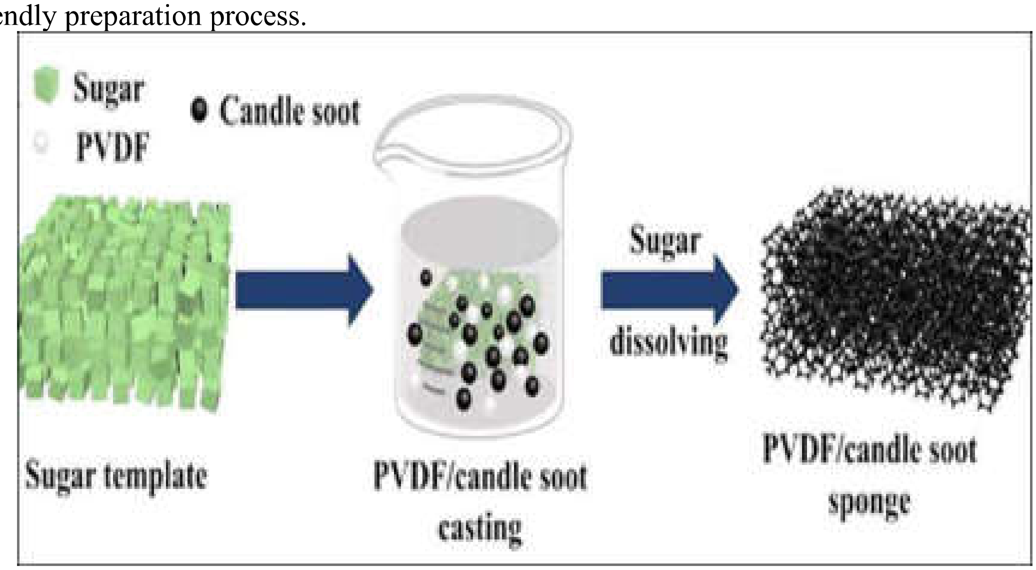

Fig. 4. Schematic illustration of the fabrication of porous PVDF/candle soot sponge using sugar template. Images reprinted from [19], with permission from Elsevier, Copyright 2021.

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2.2 Superhydrophobic/Superoleophilic Mesh:

Li et. al. [20] deposited hydrophobic CS particles on a SS mesh by holding it in the mid-flame of a paraffin candle and then spray-coated the hydrophobic silica nanoparticles (50 nm) on it. The as-prepared carbon soot/silica nanoparticles (CS/SiO_2) hybrid mesh revealed strong repellence toward pure water and droplets of pH ranging from 1 to 14, whereas the oil drops quickly spread on the surface. The hybrid mesh revealed the strong ability to separate various oils and organic liquids mixed in pure water, hot water (92°C), and strong corrosive solutions (1M HCl, NaOH, and NaCl) with more than 98% separation efficiency. The oil/water separation was performed as shown in Fig. 5. Because of the excellent mechanical flexibility of the stainless-steel mesh, the mesh was folded into a three-dimensional structure and then coated with CS and hydrophobic silica for oil/water separation. The coated mesh was placed on a beaker and a mixture of kerosene and water was poured onto the three-dimensional superhydrophobic mesh, as shown in **Fig. 5 (a-c)**. Kerosene was dropped into the beaker, while water was repelled and retained above the mesh. **Fig. 5d** exhibited that there are no oily droplets were present in the water. After the separation, a nearly equal amount of water and kerosene were collected, which suggested the extremely high separation efficiency of the coated mesh as shown in **Fig. 5e**.

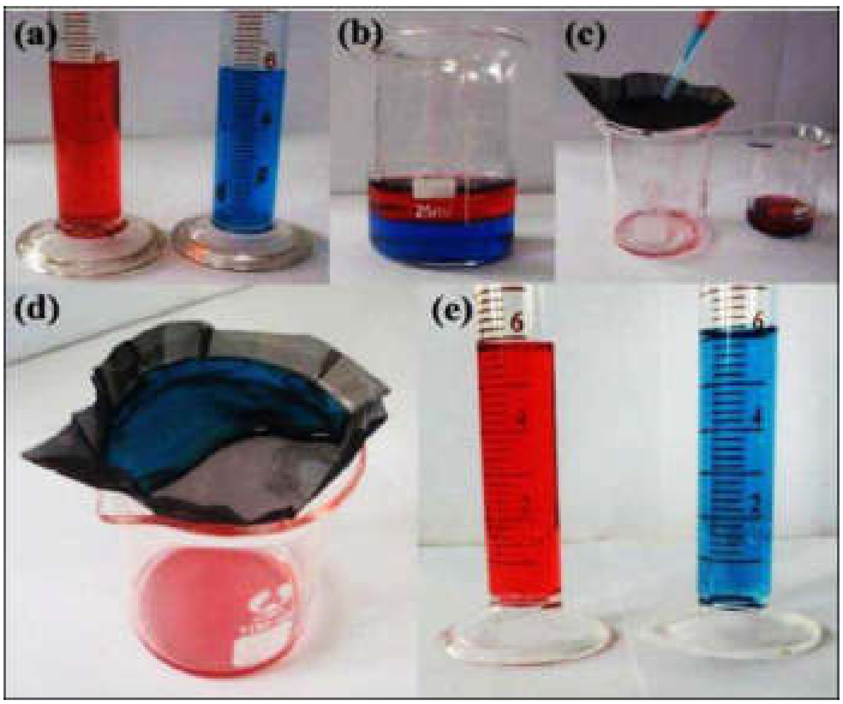

Fig. 5. Schematic illustration of the separation process of oil (kerosene)/water mixture based on the CS and silica overlap coated mesh. (a-b) water is dyed with methylene blue and oil is dyed with Oil Red O and then they are mixed before separation. (c-d) the separation process of the oil/water mixture using the overlap-coated mesh. (e) The water and oil volume remained nearly the same after separation [20], with permission from RSC Nanoscale, Copyright 2016.

Cao et al. [21] used the electrodeposition technique for the formation of superhydrophobic/superoleophilic copper meshes and then held it above candle flame to deposit carbon soot (CS) nanoparticles. The agglomerated CS nanoparticles formed a chain-like rough hierarchical structure on which the water drop exhibited a contact angle higher than 153°. The CS deposited copper mesh quickly separated various oils such as silicone oil, cyclohexane, n-hexane, n-heptane, petroleum ether, and liquid paraffin from oil-water mixtures with oil separation efficiency greater than 90% even after 30 separation cycles. The rough mesh was placed at 1.5 cm height of the flame of a burning candle for deposition for 5 minutes, the whole preparation process is shown in the **Fig. 6,** the superhydrophobic mesh surface was formed by using candle soot.

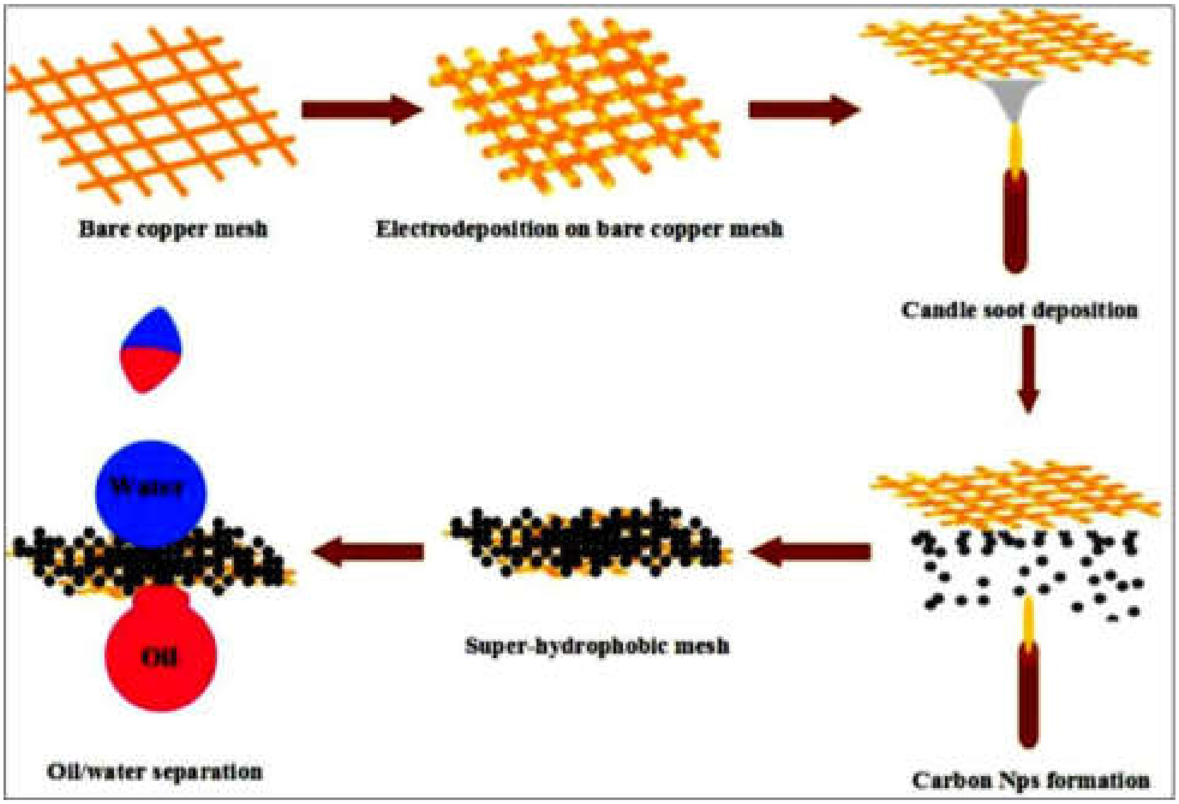

Fig. 6. Schematic illustration of the preparation process of super-hydrophobic and super-oleophilic copper mesh, and the application in oil-water separation [21], with permission from Colloids and Surfaces A: Physicochem. Eng. Aspects, Copyright 2017.

Zulfiqar et al. [22] deposited cheaply available sawdust on polychloroprene adhesive-coated SS mesh with subsequent deposition of silicone polymer by dip coating. Thereafter, a thin layer of CS particles was applied to the as-prepared mesh by holding it above a candle flame. The carbon soot (CS) nanoparticles uniformly deposited on silicone-covered SD exhibited highly rough and porous morphology required for superhydrophobicity and superoleophobicity. As depicted in **Fig. 7**, a superhydrophobic SS mesh easily and rapidly separates the oil-water mixture. No trace of water was observed in separated oil confirming its potential in oil-water separation capability. Apart from excellent oil-water separation efficiency (>95%), the superhydrophobic SS mesh exhibited good recyclability, reusability, and mechanical stability. The potential of these coatings for oil/water separation is shown in **Fig. 7**. The figure typically shows a mesh coated with superhydrophobic material holding water without any leakage. The superhydrophobic mesh was used for the separation of oil from oil-water mixtures as shown in **Fig. 7**. The mesh readily separated the oil while blocking the flow of water through its pores. The water content was not found in the separated oil, which confirms the excellent superhydrophobic/superoleophilic properties. The steel mesh with excellent mechanical stability modified with durable superhydrophobic coating can be used as a medium for oil/water separation.

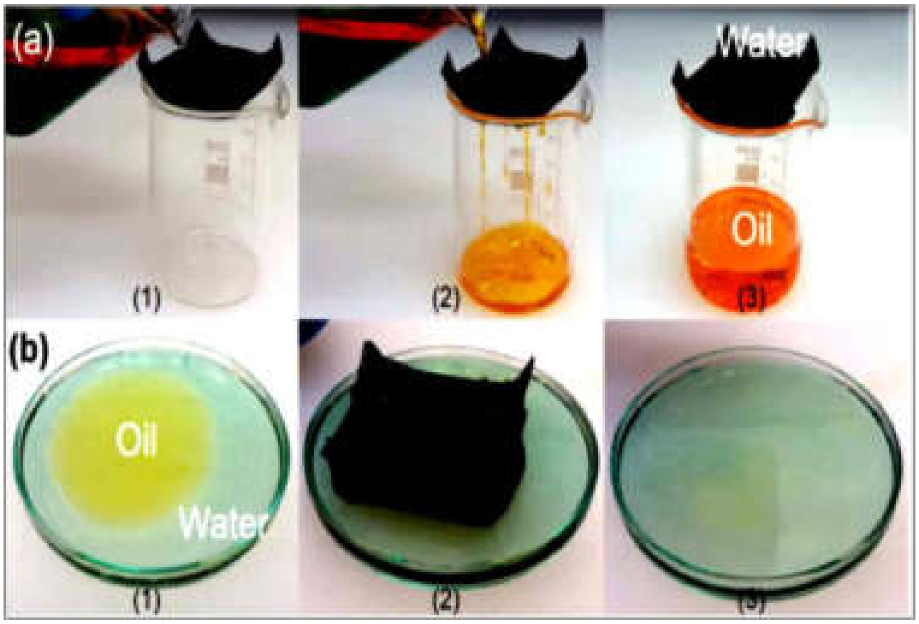

Fig. 7. Schematic illustration of a superhydrophobic mesh demonstrating (a) the separation of oil/water mixture and (b) collection of oil from oil/water mixture [22], with permission from Colloids and Surfaces A: Physicochem. Eng. Aspects, Copyright 2017.

To achieve a robust, transparent, and superhydrophobic coating, the substrate was first thoroughly washed with ethanol and deionized water thoroughly and dried in an oven at 60°C. The cleaned substrate was then placed over the candle flame until a few microns thick layer of soot was deposited. Subsequently, the soot-coated substrate together with $SiCl_4$ was placed in a drier for chemical vapor deposition for about 2 h. Finally, a superhydrophobic coating was obtained on the substrate caused by stable oxane bonds formed between abundant hydroxyl radicals on the silica shell and silane. Furthermore, to investigate the oil-water separation application of this transparent, robust, and superhydrophobic coating, a rounded stainless-steel mesh was utilized as a substrate to perform the modification **(Fig. 8)**. The rough surface formed by accumulating candle soot nanoparticles showed a significant superhydrophobicity with a water contact angle of 154.4° and it remained good oil flow rate and oil-water separation efficiency even after 6 times reuses [23].

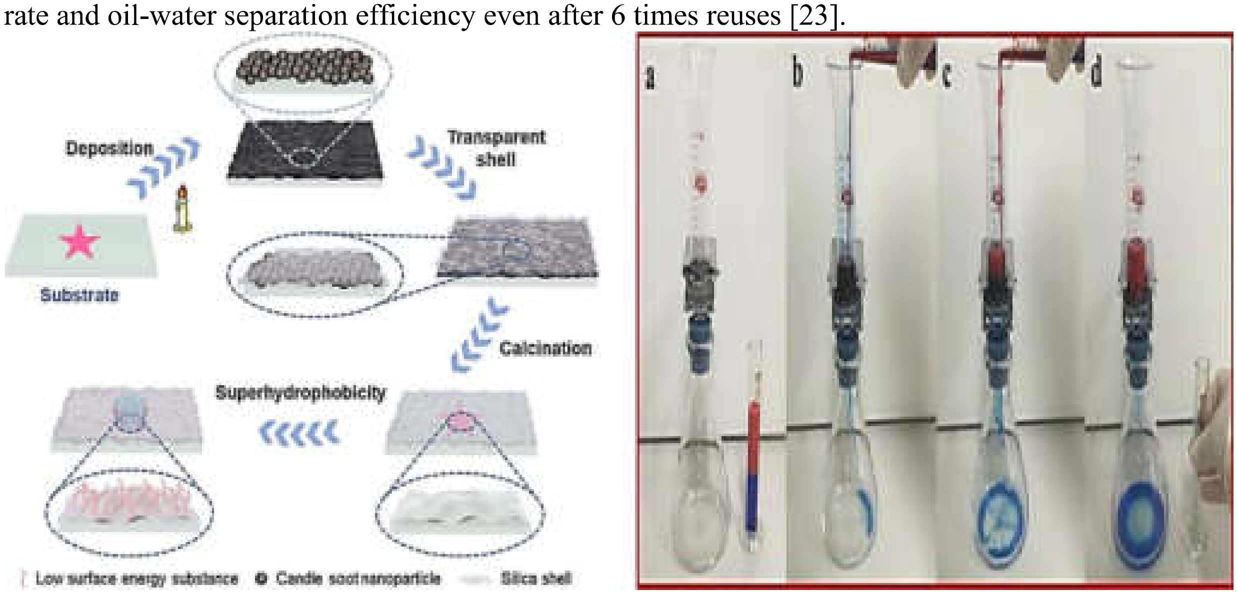

Fig. 8. Schematic of preparation and properties of the transparent and robust superhydrophobic coating and oil–water separation. Images reprinted from [23], with permission from Nature, Copyright 2022.

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The stainless-steel mesh was ultrasonically cleaned using acetone, ethanol, and deionized water for 5 min, respectively, and then dried in a blast oven at 80°C for 10 min. Then, it was put on the candle flame with a height of 1.5 cm to collect candle soot and the whole process continued for 15 seconds. Then, the prepared sample was immersed in PDMS and xylene solution of 1.5 g PDMS dissolved in 50 mL xylene. Then, the mesh was placed in a blast oven at 80°C for 10 min. Secondly, repeat the collection process of candle soot and then put it in a blast oven at 80°C for 120 min. The as-prepared mesh was named SH-M and the schematic for the preparation process is shown in **Fig. 9.** The SH-M can show a highly superhydrophobic surface such as a water contact angle is 156° and a sliding angle of less than 5° [24].

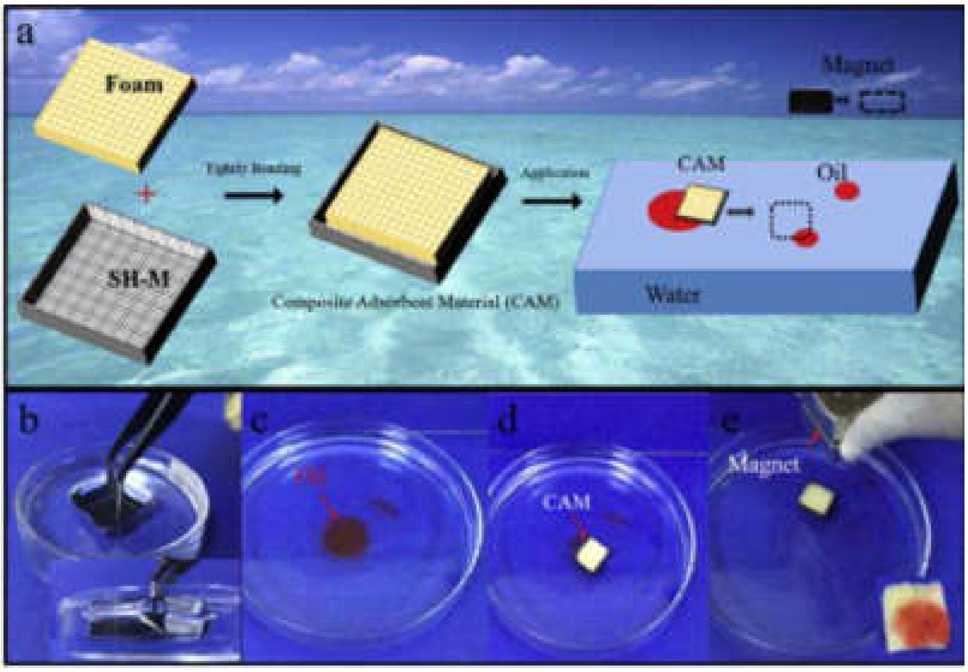

Fig. 9. (a) Schematic for the preparation process of composite adsorbent material (CAM) from the SH-M square boat and polymer foam, as well as its application of magnet drive for oil/water separation; (b) SH-M square boat immersion in water by force; (c–e) picture of the magnet drive CAM oil adsorption process [24], with permission from Progress in Organic Coatings, Copyright 2019.

A stainless-steel mesh was placed above the wick and soot was collected on the surface. The 10 nm carbon nanoparticles were coated onto the stainless-steel mesh. Then, we used a chemical vapor deposition method to form a more stable layer of SiO_2/carbon on the stainless-steel mesh. Finally, the SiO_2/carbon stainless steel mesh was modified with PFO and PDA-PFO, respectively to form the superhydrophobic/superoleophobic and oleophobic/superhydrophilic mesh membrane **(Fig. 10).** Separation experiments show that these superhydrophobic/superoleophobic or oleophobic/superhydrophilic mesh membranes can be used to selectively separate oil-water with a high flux of more than 930 L m^{-2} h^{-1} and a collecting efficiency of over 97%. Furthermore, the repetitions of the separation experiments demonstrate that these superhydrophobic/superoleophilic or oleophobic/superhydrophilic mesh membranes are durable, stable, and reusable, making them encouraging candidates for practical oil-polluted water treatment [25].

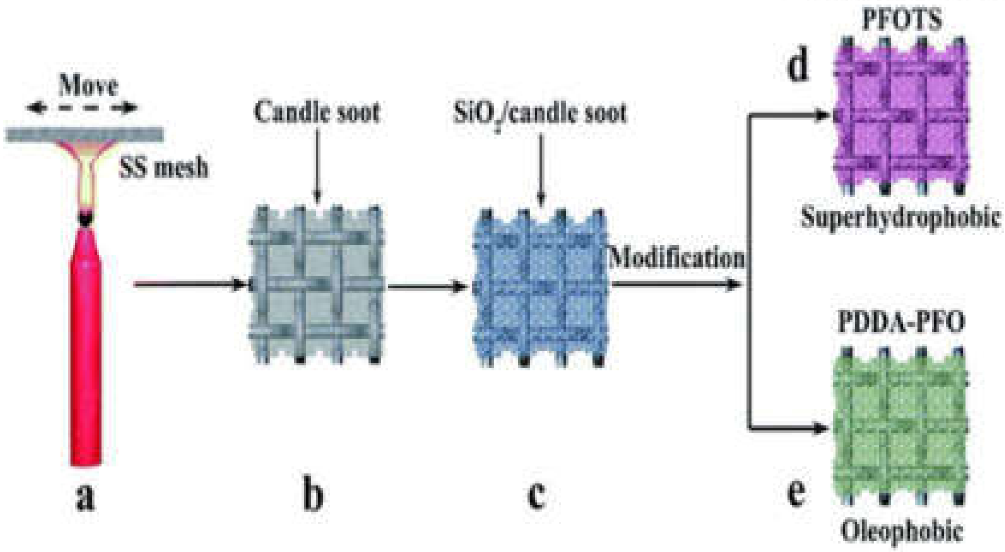

Fig. 10. Process of superhydrophobic and oleophobic mesh membranes preparation: (a) coating stainless steel mesh with carbon nanoparticle (candle soot), (b) carbon nanoparticle coated stainless steel mesh, (c) SiO_2/carbon stainless steel mesh, (d) PFOTS modified SiO_2/carbon stainless steel mesh, (e) PDDA–PFO modified SiO_2/carbon stainless steel mesh [25], with permission from RSC Adv., Copyright 2017.

Mesh prepared with a PFCS coating can be used to separate oil. After cutting a piece of iron mesh and coating the mesh with paraffin wax, a metal sheet was patched onto the back of the mesh with sot from a candle flame a superhydrophobic mesh coating is oleophilic, and a water drop cannot penetrate through the mesh, but Polydimethylsiloxane (PDMS) oil can as be shown in Fig. 8, shows a side view of the drops. While the water drop remains on the mesh, the PDMS oil drop with a low surface tension passes through the mesh and dongles from the mesh. The mixture of water and PDMS oil was easily separated with the mesh. This mesh can be effective in oil collection systems and functional filtration systems [26].

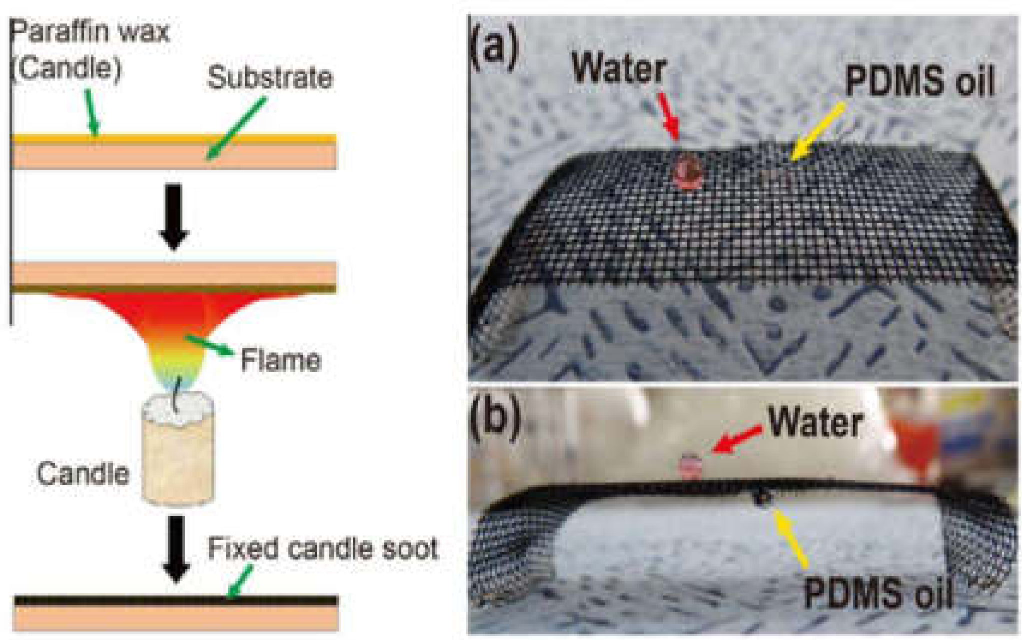

Fig. 11. A scheme for the fabrication of a stable superhydrophobic surface by using only a candle and a superhydrophobic mesh prepared with a PFCS coating [26], with permission from Carbon, Copyright 2014.

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2.3 Superhydrophobic/Superoleophilic Foam:

The superhydrophobic and superoleophilic surface was fabricated by candle soot coating and sequential modification with PDMS. Nickel foam was cleaned by alternate ultra-sonication in ethanol and Milli-Q water three times and then dried in the oven. Afterward, the surface to be coated, in our case a nickel foam, is held above the flame of a paraffin candle. About 5 min. After the ignition of the candle, a steady flame was obtained with a total flame height of 4 cm. Ni foam (5 cm × 5 cm) was mounted in the flame envelope 3.5 cm above the candle. The growth process lasted for 2 min for the one side and then for another 2 min for the other side with Ni foam moving back and forth, after which the Ni foam was taken out from the flame. Deposition of a soot layer turns the nickel foam black. The candle soot-coated nickel foam was placed into a petri dish in which a mixture of hexane, PDMS pre-polymer, and thermal curing agent was poured in a ratio of 100:10:1 by weight. The candle soot-coated nickel foam with the absorbed mixture was then cured at 80°C for 4 hours as shown in **Fig. 12.** The prepared nickel foam showed excellent superhydrophobicity with a water contact angle as high as 152°. These research results show evidence that the coating of candle soot can be applied to a wide variety of heat-resistant surfaces and is effective for the separation of water and oil mixture [27].

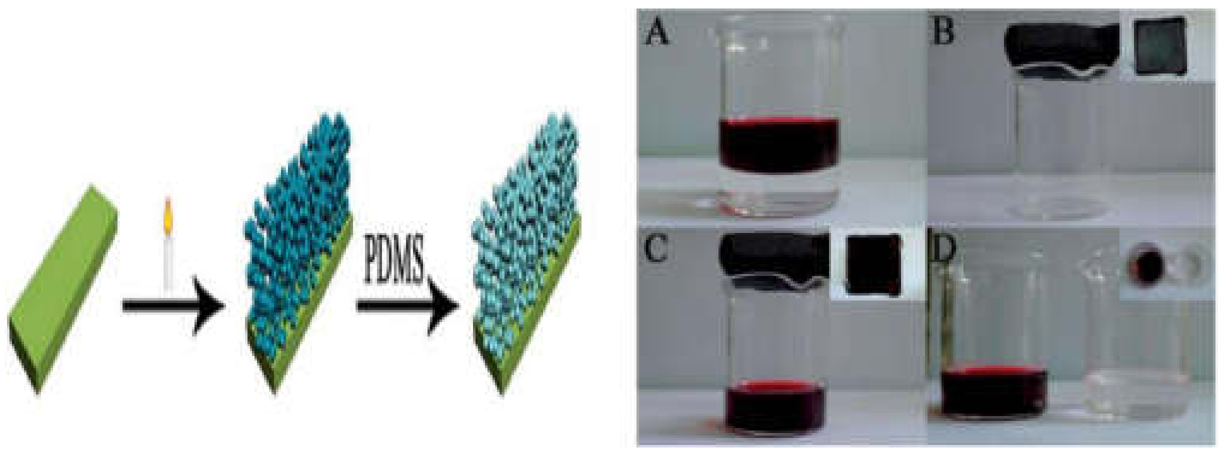

Fig. 12. Preparing superhydrophobic and superoleophilic nickel foam and Experiment process images of the water purification using superhydrophobic and superoleophilic nickel foam [27], with permission from RSC Adv., Copyright 2014.

The Nickel foam was cut into several small pieces of 3 cm × 3 cm and then placed in an ultrasonic cleaner with ethanol for 30 min washed with deionized water 3 times and dried in an oven at 60°C. The stable suspension liquid was obtained by adding 0.1 g CNPs, 1 g PDMS, and 0.1 g curing agent to 50 mL n-hexane, and then ultrasonic treatment at 30 kHz for 1 h. The clean and dried Ni foam chips are immersed in the above suspension and left at ambient temperature until the solvent evaporates to dryness, afterwards, the mixture of CNPs and PDMS is uniformly deposited on the inside and surface of the Ni foam. Then, place it in a muffle furnace at 100°C for 1 h. to make it solidify. Finally, five of the above prepared small pieces were pressed into the NF/CNP-PDMS with a size of 3 cm × 3 cm × 2 mm by pressing the machine **(Fig. 13)**. It can show superhydrophobic properties with a WCA of 153° and an oil contact angle of nearly 0°. It shows the substrate is superhydrophobic and easily separates the oil from water [28].

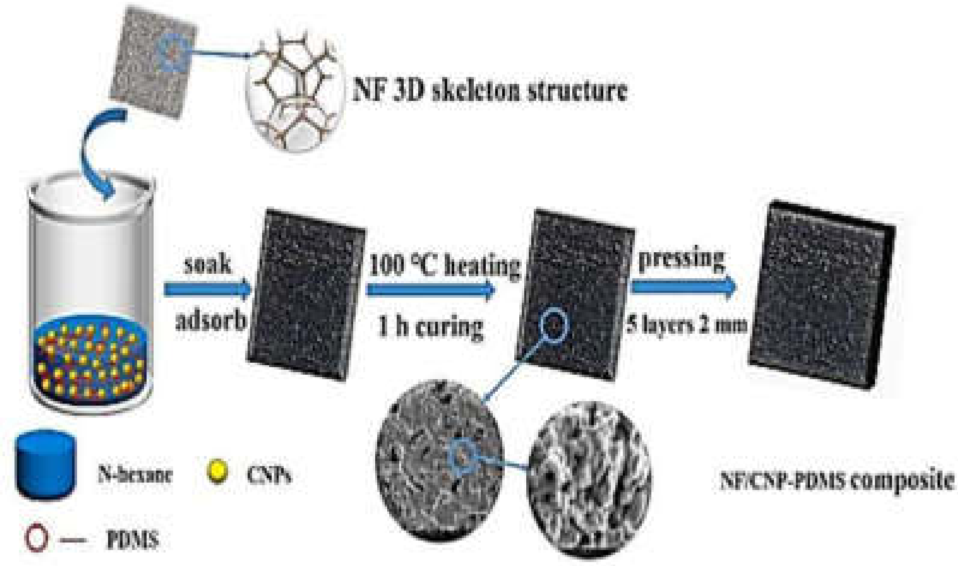

Fig. 13. Schematic diagram of NF/CNP-PDMS composite preparation [28], with permission from Colloids and Surfaces A: Physicochem. and Eng. Aspects, Copyright 2021.

The fabrication process is firstly, CNTs were dispersed in THF by sonication for 30 min. Then, PS (Polystyrene) and CA (Cinnamic Acid) were dissolved in the CNTs-THF dispersion. The mixture was stirred for 2 h and sonicated for 30 min to reach homogeneity. Subsequently, distilled water was poured into the suspension to induce phase inversion and form the PS/CNTs/CA foam. The foam was dried and then immersed in isopropyl alcohol for 3 h to remove the CA. The PS/CNTs foam was obtained after drying. For comparison the pure PS foam was fabricated by the same two-step strategy **(Fig. 14).** It can show a water contact angle of 161.2° and excellent water repellence, with great application potential in the treatment of oil spills [29].

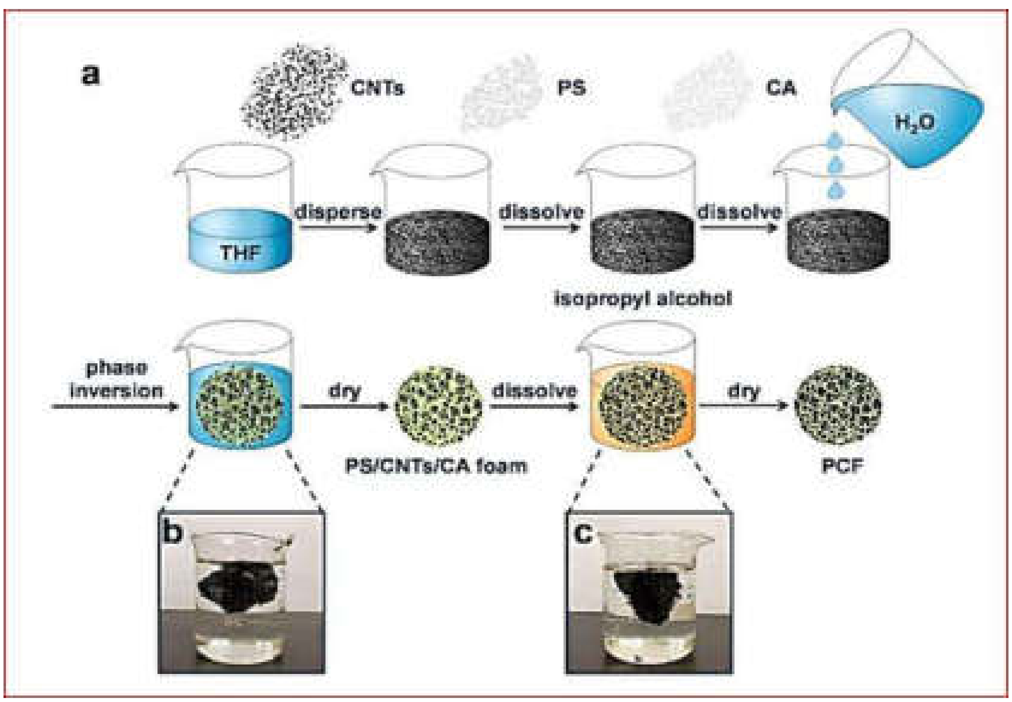

Fig. 14. (a) Schematic illustration of the fabrication process of the PCF; (b) photograph of the PS/CNTs/CA foam in water; (c) photograph of the PCF in isopropyl alcohol [29], with permission from J. Env. Chem. Eng., Copyright 2021.

Conclusion:

As this review highlights, candle soot nanoparticles are unique in that, their fabrication requires little control of external parameters. It is very economical beneficial, facile, and straightforward to synthesize. Candle soot-coated sponge/mesh for use in oil-water separation has been developed by using CS nanoparticles and different polymers. The candle soot synthesis, candle soot coated sponge/mesh preparation, procedures are simple, cost-effective, and scalable. The absorption/separation investigation demonstrates that the candle soot sponge/mesh is highly efficient and stable in absorbing a wide range of oil and organic solvents. It can be believed that the candle-soot-coated superhydrophobic materials are very useful for oil-water separation. It shows various tremendous results with candle soot-polymer composite in various mechanical conditions. Candle soot nanoparticles show a significant surface area-to-volume ratio and high electronic and ionic conductivity. Candle soot is produced by simply burning candles and hence, it is eco-friendly, economical, and useful. Candle soot-coated sponge/mesh can show stability, durability, reusability, and reproducibility.

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STUDY OF LITERATURE AND LANGUAGE: OPPORTUNITIES AND CHALLENGES IN THE AI ERA

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Content…

A Study of Challenges in the Use of AI-empowered Education in the Context of India

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Abstract:

According to various international reports, AI-empowered education is one of the emerging fields in education and pedagogy. There is an utmost need to examine more prudently and critically the opportunities and challenges brought by AI generated apps in literary study and creation. The paper aims at exploring and analysing multiple challenges in the use of AI-empowered education for the study of literature. The entire world especially the developed countries are on the threshold of a new era in the way of learning especially through AI-empowered education. AI is a booming and leading technological domain, but in the developing countries like India, it is very challenging to integrate AI-empowered education at the grassroots of rural and remote area.

Key words: AI-empowered education, literature, NEP-2020, upskilling teachers, pedagogy.

Introduction:

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There is a considerable increase in the use of Artificial Intelligence (AI) technologies in education sector. The field of AI in education (AIEd) has demonstrated technological advances and innovations in education sector (Roll & Wylie, 2016). One of the biggest benefits of AI in education is the personalised learning according to the preferences of each student. Here, a student can learn according to his or her own preferences, pace, time, capability and interest. Presently, it has offered multiple useful applications such as intelligent machine tutors for content delivery, feedback provision, and progress supervision (Bayne, 2015). Besides, diverse AI-empowered educational technologies can be used to study and analyze classroom dynamics and students' active engagement in teaching-learning process (Tsai et al., 2020).

Many scholars are promoting the application of AI-empowered education for effective outputs as there is a noticeable rapid growth of AIEd in research sector.

Challenges in the Context of India:

Basically, the AI-empowered education ecosystem requires advanced infrastructures and a boosting ambience of thriving innovators. In NEP-2020, there is a discussion on the integration of essential subjects like artificial intelligence education in concerted curricular and pedagogical initiatives. In order to strengthen and make Indian ecosystem of research very robust, NEP-2020 underscores that the nation will require a significant expansion of its research capabilities and output across disciplines like machine learning, artificial intelligence, biotechnology, and expanding digital marketplace(Govt. of India, NEP-2020, 44). The challenge of advanced infrastructures and a boosting ambience for AI-empowered education especially in rural and remote area of India is the first and foremost challenge in education sector.

The second challenge is the smooth and effective collaboration between AI and teachers in India. It is very challenging to leverage the best attributes of both machines and teachers for effective and fruitful results in remote and rural India. To give the best attributes, teachers in India should adopt the optimistic standpoint towards AI. They should be well trained and oriented about the use of AI in education. There is need to remove and bridge the digital divide through training programmes. So there is need of upskilling teachers for better collaboration between AI and teachers in India.

It is really challenging to know that AI can really understand the literature or the meaning between the lines. Ironical statements, the meaning between the lines, inter-textual references, and emotional references are some areas in literature where the AI-empowered elucidation becomes more doubtful. As the AI, presently, is at a threshold of development, it is more challenging for the educators and learners to make effective use of AI-based pedagogical study.

We know that AI is an artificial flower without smell made of synthetic material. AI cannot distinguish between the impacts of social changes on the writing. AI cannot create a new and innovative perspective towards a literary text. It only works on the input material. In technical thing, AI is better but on the other hand, in the field of human feelings and emotions, it has some limitations too. AI is a tool. It cannot give human touch. It can be more useful in the form of data. Understanding genuine emotions reflected in literary works like novels, poems, etc. is one of the essential challenging tasks for AI tools. Data theft is a serious concern in the use of AI-empowered applications. Due to the digital identity theft issue, it is very challenging to convince the teachers and students about the use of such apps.

Pedagogy should not be unnecessarily affected by the use of AI-empowered education. AI should support, enhance, innovate and make the teaching-learning more fruitful instead of replacing it. This is unavoidable concern among the teachers. Affordable and easy access technology though internet is also one of the major challenges in India.

In brief, it is pretty clear that the potential application of artificial intelligence is huge and vast. It is need of the hour to learn AI tools and applications; therefore, Indian teacher should advocate new modern styles of teaching and make the teaching-learning process very fruitful. We can say that in the context of India, artificial intelligence is capable of complementing the genius of the human brain, but it has some limitations of offering quality education based on the overall needs of a learner from diverse sectors especially in Indian society.

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Content…

A Study of Challenges in the Use of AI-empowered Education in the Context of India

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Dr. L.V. Bhargande
Assistant Professor, Raje Ramrao Mahavidyalaya, Jath

Abstract:

According to various international reports, AI-empowered education is one of the emerging fields in education and pedagogy. There is an utmost need to examine more prudently and critically the opportunities and challenges brought by AI generated apps in literary study and creation. The paper aims at exploring and analysing multiple challenges in the use of AI-empowered education for the study of literature. The entire world especially the developed countries are on the threshold of a new era in the way of learning especially through AI-empowered education. AI is a booming and leading technological domain, but in the developing countries like India, it is very challenging to integrate AI-empowered education at the grassroots of rural and remote area.

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