Project Synopsis: Superhydrophobic Coating Using Candle Soot

1. Aim

To prepare a superhydrophobic surface using candle soot and to study its water-repellent properties for potential applications such as self-cleaning surfaces and corrosion resistance.

2. Introduction

Superhydrophobic surfaces are those that repel water strongly, causing water droplets to roll off easily instead of wetting the surface. This property is due to the surface roughness at the micro/nano scale combined with low surface energy materials. In this project, we use candle soot as a simple, low-cost, and eco-friendly material to create such a coating. The soot particles consist mainly of carbon nanoparticles, which provide the required roughness and hydrophobic nature. This experiment helps to understand the concept of contact angle, surface tension, and the lotus effect found in nature.

3. Selection of Problem and Background Research

In many industries, surfaces are easily contaminated by water, dust, or oil, leading to corrosion or reduced efficiency. Traditional hydrophobic coatings are expensive and involve toxic chemicals. Candle soot provides a sustainable alternative since it is easily available and can be applied without complex instruments. Research shows that soot particles, when deposited on glass or metal, form a nanostructured layer capable of producing high water contact angles (>150°), classifying it as superhydrophobic. This study explores whether such coatings can be made easily in school-level laboratories and still show effective water repellence.

4. Statement of the Problem

To investigate whether a coating made from candle soot can exhibit superhydrophobic properties and to evaluate its effectiveness compared to an uncoated surface.

5. Hypothesis

If a surface is coated with candle soot, then water droplets will not spread or stick to it but will roll off easily, showing superhydrophobic behavior.

6. Variables – Dependent, Independent, Control

Independent Variable: Type of coating (soot-coated vs. uncoated surface).
Dependent Variable: Water contact angle / degree of water repellence.
Controlled Variables: Type of substrate (glass slide or metal plate), size of water droplet, temperature, and humidity during testing.

7. Procedure

1. Take a clean glass slide or metal plate.
2. Hold it carefully above a candle flame so that black soot deposits evenly on the surface.

3. Allow the coating to cool and stabilize.
4. Using a dropper, place a few drops of water on the coated surface.
5. Observe the behavior of water droplets — whether they spread or roll off.
6. Compare this with an uncoated surface.
7. Optionally, use a protractor or smartphone camera to estimate the water contact angle.
8. Record observations, photographs, and results.

Safety Note: Perform the experiment under supervision, away from flammable materials.

8. Result

The soot-coated surface shows clear water-repellent behavior. Water droplets remain spherical and roll off the surface easily without leaving wet marks. In contrast, the uncoated surface shows water spreading and wetting. This confirms that candle soot forms a rough, hydrophobic layer responsible for superhydrophobic properties.

9. Conclusion

The experiment successfully demonstrates that a simple candle soot coating can produce a superhydrophobic surface. The carbon nanoparticles in soot increase surface roughness, causing water to bead up and roll off. Thus, the hypothesis is verified — soot-coated surfaces display strong water-repellent behavior.

10. Application

- Self-cleaning glass and windows
- Anti-corrosion metal coatings
- Waterproof textiles and electronic devices
- Reduction of drag in fluid systems
- Dust-resistant solar panels

11. Future Enhancement

- Testing the durability of the coating under abrasion or washing.
- Improving adhesion using fixatives like silica or polymer binders.
- Measuring exact contact angles using a goniometer.
- Extending the method to various substrates such as paper, plastic, or metal.
- Developing eco-friendly large-scale fabrication techniques.

12. Reference

1. Bhushan, B. & Jung, Y.C. “Natural and biomimetic artificial surfaces for superhydrophobicity, self-cleaning, and low adhesion.” Progress in Materials Science, 2008.
2. Liu, T. et al. “Fabrication of superhydrophobic surfaces using candle soot.” Applied Surface Science, 2011.
3. National Institute of Standards and Technology (NIST) – Research on water contact angle measurement.
4. School and college-level chemistry project references on nanomaterials and coatings.

5. Internet sources: ScienceDirect, ResearchGate, Wikipedia articles on superhydrophobicity and candle soot coating.