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Creation based on superhydrophobic soot waterproofing materials obtained in flames

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Abstract. In this paper we present a study of the formation of soot, which has the properties of the superhydrophobic surface of a silicon substrate. Found that the soot content in the putty from 1 to 8% increase in the hydrophobic properties of plaster.

Introduction

Currently, the construction market in need of high quality, durable and most importantly, the available technologies of production of waterproofing materials. To date, almost all underground infrastructure facilities or structures located in aggressive environments, after a certain period of service, have violation integrity and performance of the waterproofing system. Creating highly reliable waterproofing materials with nanostructures will help solve the problem of the negative impact of a wet environment and aggressive groundwater. As a nanostructured material can use soot with superhydrophobic properties, obtained under certain condition burning of hydrocarbon fuels [1-3]. In this paper we present studies of the formation of carbon black having superhydrophobic properties on the surface of the silicon substrate.

Experimental

We studied the process condensation of soot particles on the surface of a silicon wafer by burning propane - oxygen flame. In Fig. 1 shows the setup.

Fig. 1. An experimental setting.

Superhydrophobic carbon black was synthesized by the burning of propane - oxygen flame. The plate is accomplished by either silicon or nickel was placed in the flame of a mixture of hydrocarbons with oxygen, at a height of 2 - 3 cm from the burner. The feed rate of hydrocarbons ranged from 50 to 150 cm^3/min, and the oxygen from 260 to 310 cm^3/min at atmospheric pressure, for 4 - 10 min.ranged from 50 to 150 cm^3/min, and the oxygen from 260 to 310 cm^3/min at atmospheric pressure, for 4 - 10 min.

Propane and oxygen are fed separately to the burner outlet to form a diffusion flame. Hydrophobic soot in the form of nanospherical structures 20 - 50 nm, formed in nanobeads, is deposited on the plate thickness of 1.5 mm (Fig. 2).

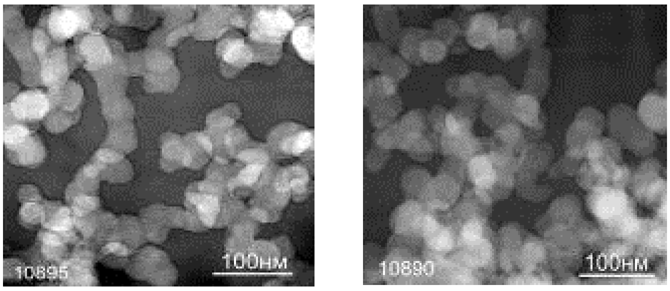

Fig. 2. Electron microscopic images of samples of carbon black.

Results and Discussion

Determination of the hydrophobic properties of the obtained soot surface was carried out by sessile drop method, the essence of which is to measure the contact angle on the line interface. At the same hydrophobicity, determined wetting angle is equal to 170^o (Fig. 3).

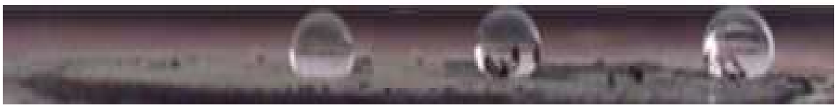

Fig. 3. The behaviour of water droplets on a silicon substrate with the deposited hydrophobic soot on it.

Next, the obtained superhydrophobic soot added as filler to the putty type T-37 at concentrations of 1, 2, 3, 4, 6, 8, 10, and 15% by weight of the base material. Thoroughly stirred mixture was applied to the drywall and dried for 5 days at room temperature.

After five days, the samples were examined for hydrophobicity by the sessile drop. Studies have shown that the addition of carbon black increases the hydrophobic properties of the putty to a certain limit, the maximum contact angle (above 150^o) was observed at concentrations of soot, equal to 8%. However, already at 10% concentration, the surface putty loses its hydrophobic properties and begins to absorb water easily. Further increase of the content soot to 15% deteriorates the plastic and strength properties of the coating; it helps to cracking and loss of primary purpose, as a material for primary processing and protection of plaster (Fig. 4).

Studies have shown that the use of superhydrophobic carbon black as filler imparts water repellency is not only the surface layer of putty, but the whole of its volume, which significantly increases protection against penetration of moisture. The introduction of small amounts of soot also contributes to the increase the hardness off and wears resistance of the coating. In addition obtained hydrophobic coating characterized with a high adhesion to various surfaces and has a high penetrating power.

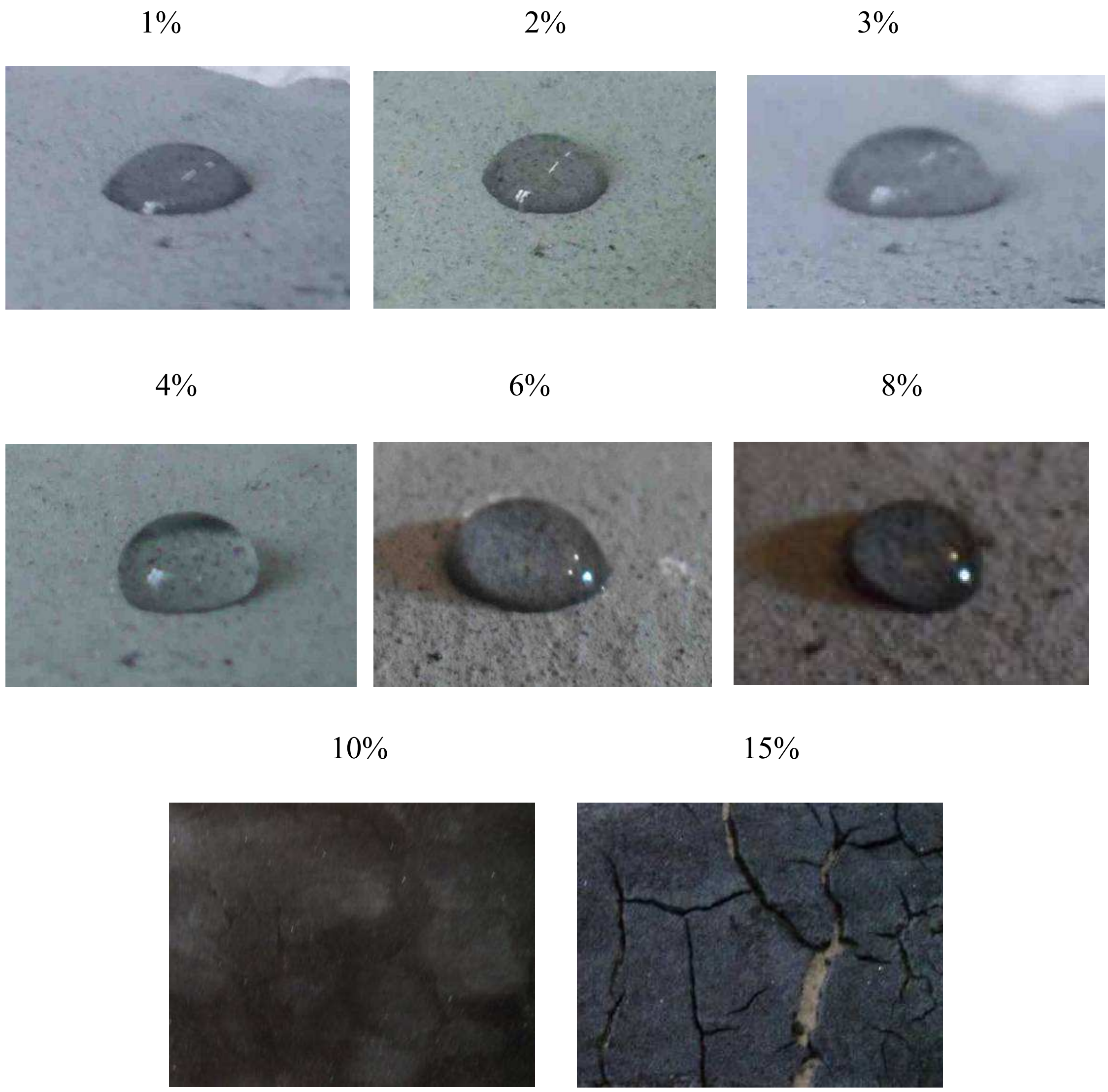

Fig. 4. A drop of water on a layer of putty, applied to drywall.

Fig. 4 shows the behavior of water droplets deposited on the surface of the obtained hydrophobic putty. From the figures it is clear that by increasing content of soot from 1 to 8% there is an increase of hydrophobic properties of the coating plaster material, a further increase in the percentage of the total amount of soot in the mixture till 10-15% is impractical because there is a sharp decline, as the hydrophobic and basic properties putty.

Fig. 5 shows a plot of contact angle on the percentage of soot obtained superhydrophobic putty.

Were carried out investigation of the effect adding the obtained superhydrophobic soot in the acrylic polymer is used as a primer. We used acrylic polymer grade Mowital B 30 H. We studied the dynamics of water absorption on the surface of clear gipsokartona, drywall treated with acrylic polymer and gypsum-treated acrylic polymer which is added 10% of the mass ratio of soot obtained superhydrophobic. The prepared samples were dried for 3 days at room temperature.

The behavior of water on the surface of prepared gypsum board are shown in Fig.6. The untreated surface is easy to absorb water (Fig. 6, a), the surface treated with pure polymer absorbs water from within 1 hour, and the water on the surface coated with an acrylic polymer with the addition of soot does not absorb water for a few days.

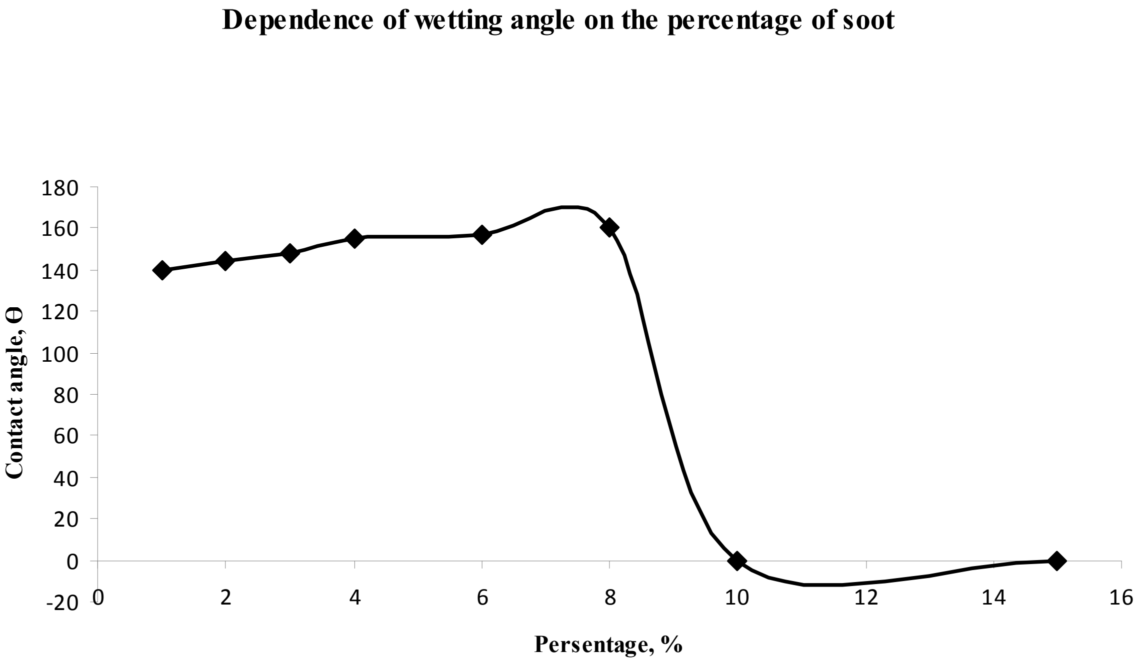

Fig. 5. The dependence of wetting angle on the percentage of soot, %

(a) (b) (c)

Fig. 6. The behavior of water on the surface prepared plasterboard.

Conclusions

Found that the soot content in the putty from 1 to 8% increase in the hydrophobic properties of Plaster coating. Further increase of the carbon black deteriorates plastic and strength properties of Plaster coating contributes to its cracking, reducing the coefficient of opacity and loss of basic properties.

Found that the addition of carbon black in the superhydrophobic acrylic polymer is used as a primer makes it water resistant properties.

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