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Improving dirt resistance of cold traffic paint using nano-materials

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Abstract:

Pavement markings are used to increase road safety by providing drivers critical guidance and information. For example, centerlines have been shown to cut accident frequency by over 29%, compared to roads without them. Various types of materials can be used as road markings, and the choice depends on cost, durability, retro-reflectivity, pavement surface, and drying time. However, visual aspects can play important role in long-term performance. Nowadays cold paints are being increasingly utilized due to some advantages such as easy application compared to hot melt traffic markings. The aim of this study is to find a way to get a better dirt resistance with the aid of nanoparticles. Thus, a white cold traffic paint was prepared using concomitant loading of OH-functional silicone modified polyacrylate nano-additive (0 to 20 wt%).

Introduction:

The term "Lotus-Effect" represents the replication of the self-cleaning properties of lotus leaves on man-made surfaces. It has gained recent attention in literature as well as in some end-use applications. The effect is based on a very hydrophobic surface. This article discusses the potential for obtaining similar effects in traffic paints using additives.

A new hydroxy-(OH) functional silicone modified additive can enhance the surface-cleaning properties (cleanability) of paints and coatings. Crosslinkable by way of OH-groups, nanosilica provides long-lasting significant improvements in cleanability so that adhering dust and dirt particles as well as graffiti can be removed much easier compared to "normal" paints.

Methods:

The main objective of these studies was to prepare coatings with low surface free energy by incorporating silicone components in their formulations. This prevents the surface to be dirt. Therefore, because of the weak cohesion between cold traffic paints and dust or pollution of environment. As a result, the effect of addition BYK 3700 leads dusts to higher contact angle and lower surface energy and the use of BYK 3700 will be reduced getting dirt and the lifetime of cold traffic paint will be increase.

Different paint formulations were prepared with nano-additive by various amounts ranging from 5 to 20 wt.%, under moderate mechanical stirring. An additional formulation containing 0% additive were also prepared.

The samples were applied on concrete substrate using a film applicator. The films were left for about one hour at room temperature for full surface and deep drying.

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After the preparing the films a solution of carbon black and mineral water was prepared for testing the anti-graffiti properties.

The value of nanosilica additive that used for this article is showed in table1. The ΔE equation is defined for calculating the diffrence of anti-dirt value of each sample:

$$\Delta E* = \sqrt{(\Delta L*)^2 + (\Delta a*)^2 + (\Delta b*)^2}$$

Results:

The standard testing methods were carried out to investigate the self-cleaning performance and the optical characteristics. Compared with the conventional cold traffic paints, the modified coatings have a much higher dirt resistance due to lower surface energy with negligible gloss and color differences. It means the use of nano-materials in coating formulations can significantly promote dirt resistance of the cold traffic paints. Eventually, the results revealed that the sample containing 15wt% nano-additive has the lowest dirt pick up with color coordinates x=0.31, y=0.33.

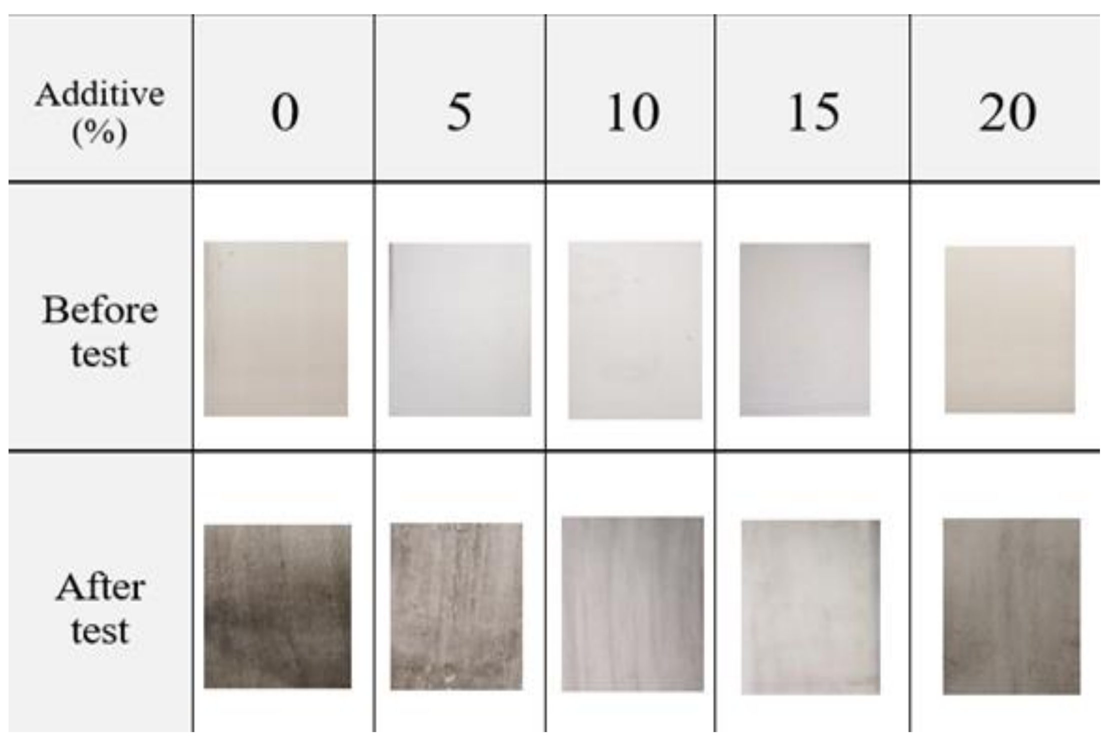

Figure 1. Visual observation of the samples dependant on additive concentration before and after dirt pick-up test

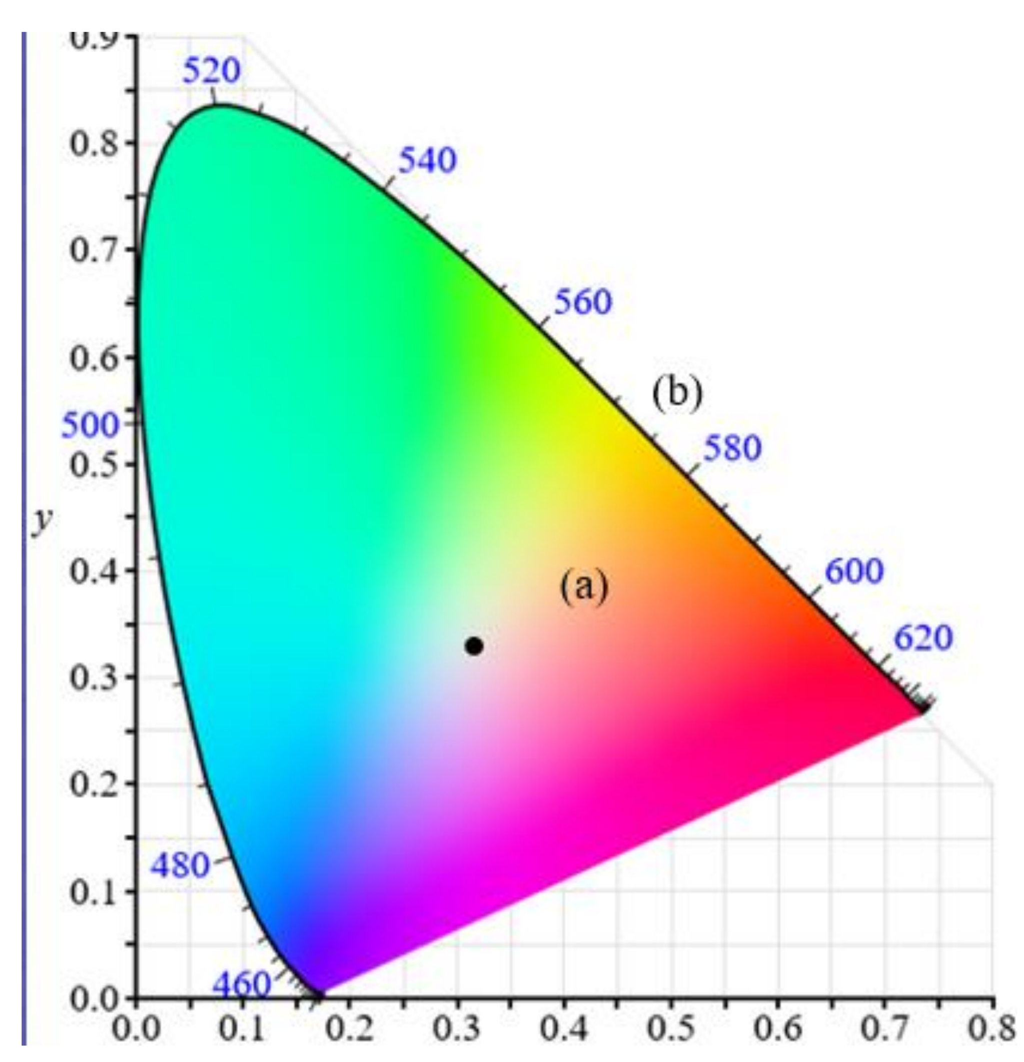

Figure 2. Color coordinates of the samples dependant on nano-additive concentration (0,5, 10, 15 and 20 wt%)
(a)The amounts of x,y,Y,L,a and b of the samples that measured by Color striker.
(b)Locus diagram of samples, the E point show the location of samples on the CIE 1931 xy chromaticity diagram.

	D0	D5	D10	D15	D20
x	0.31	0.31	0.31	0.31	0.31
y	0.33	0.33	0.33	0.33	0.33
Y	70.79	73.08	70.85	68.61	65.37
L	87.38	88.48	81.41	86.31	84.68
a	-1.23	-0.94	-0.95	-1.16	-1.08
b	-0.18	0.46	0.06	-0.42	-1.07

Table 1. The effect of additive amount on anti-dirt properties

Degree	D0	D5	D10	D15	D20
20°	1.1	1.3	1.5	1.2	1.1
60°	4.4	5.9	5.5	5.6	5.2

Table 2. The result of glossiness test is showed in the table above.

Conclusions:

A new silicone-modified acrylate additive has been developed that provides surfaces with easy cleaning characteristics along with many other interesting properties in OH-functional group systems.

In the present study a white traffic paint was prepared using concomitant loading of OH-functional silicone modified polyacrylate nano-additive (0 to 20 wt%). The standard testing methods were carried out to investigate the self-cleaning performance and the optical characteristics. Compared with the conventional cold traffic paints, the modified coatings have a much higher dirt resistance due to lower surface energy with negligible gloss and color differences ($\Delta E*\approx 5$). The results revealed that the sample containing 15wt% nano-additive has the lowest dirt pick up with color coordinates x=0.31, y=0.33.

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