Investigation on Transparency, Self-Cleaning, Tribology, and UV-Resistivity Properties of Epoxy Based Paints Filled with Nano and Micro-Sized Oxides

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Abstract

By changing the type of building floor coverings from ceramic materials to polymer materials, several advantages are provided, including the integrity of the coating, transparency, anti-slip, patternability, high durability, higher impact resistance, and many other advantages. However, the disadvantages of polymer coatings, such as less resistance to UV rays, maintenance of surface pollution, low adhesion to concrete, and the possibility of layering must be eliminated. In this research, the factors that cause the properties of self-cleaning, resistance to UV waves, transparency and high durability in the coating are studied and investigated. The self-cleaning property means that foreign particles such as particles, dust, and all organic materials cannot easily stick to the surface and can be cleaned with a little wind or rain. This property can be created by creating super hydrophobic or super hydrophilic properties in the coating. The coatings are based on resins such as epoxy. Various methods are used to create super-hydrophobic or super-hydrophilic properties. In order to obtain the mentioned properties, fillers such as TiO_2, SiO_2, Al_2O_3 and ZnO are added in nano and micro dimensions and in different volume percentages. The effect of these oxides in nano and micron dimensions is to be added to the epoxy resin, and the effective factors on the properties of self-cleaning, transparency and adhesion (lap shear) are studied and investigated.

Experimental method

Materials

The following materials were used in this research. Two-component epoxy polymer from the company, the first component is resin and the second component is hardener. TiO2, ZnO and SiO2 powders (in two dimensions, micron with an average of 200 microns and nano with an average of 30 nanometers) were purchased from Purian Chemical Company.

Analyses

Lap-shear test

To measure the apparent shear strength of the adhesive in the butt joint, the milk lap test according to the ASTM D 1002 standard is used. To perform this test, 316L stainless steel sheet with dimensions of 101.6 × 25.4 × 32 mm was used. After cutting the samples, the part of the sheet that is supposed to be coated with glue is surface cleaned. They are first sanded with 100 to 600 grit and then washed with alcohol. An area measuring 12.7 × 4.25 mm2 from the polished edge of the sheet is covered with glue. Tensile test was done by Instron 8802 machine in Shahrood University of Technology.

Drop angle test

The drop test is performed by measuring the angle of the water drop on the coating surface. The drop angle is measured with the Tensiometer IFTS.

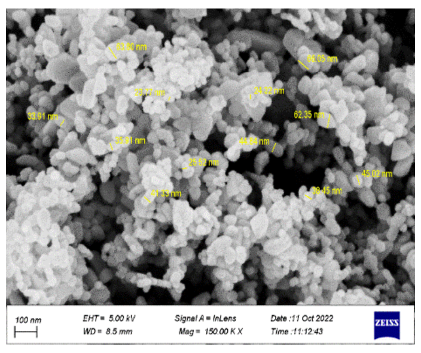
Transparency test

The transparency test is qualitatively and visually checked by comparing the samples.

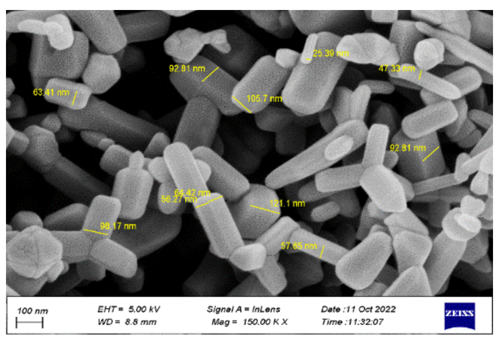
Self-cleaning test

In this test, samples are contaminated with graphite. In this way, graphite is rubbed on their surface. Then the samples are placed at an angle of 45 degrees and with water droplets that are controlled from above on the surface

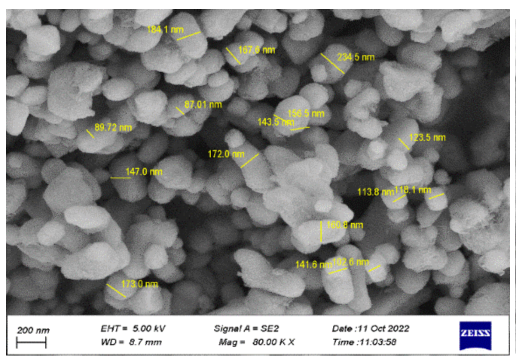
Results and discussion



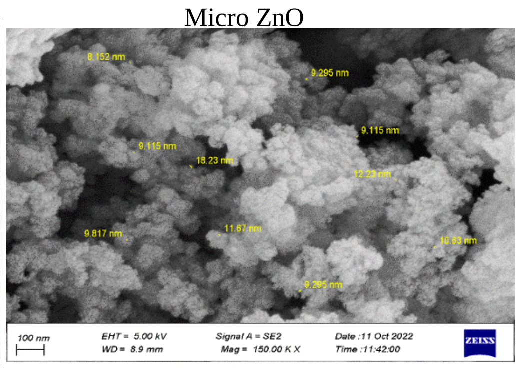
Nano ZnO



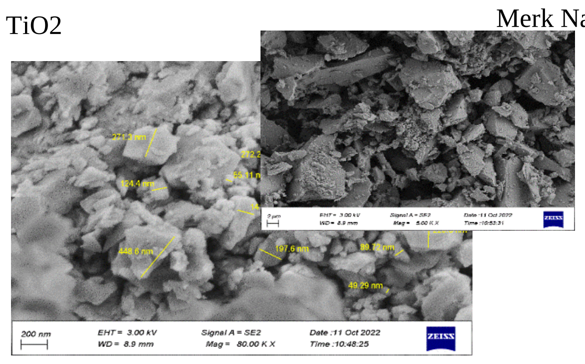
Micro ZnO



TiO2



Merk Nano SiO2



Industrial Micro SiO2

Fig.1. SEM images of different powder. It can be seen that only the Merk SiO2 powder is amorphous

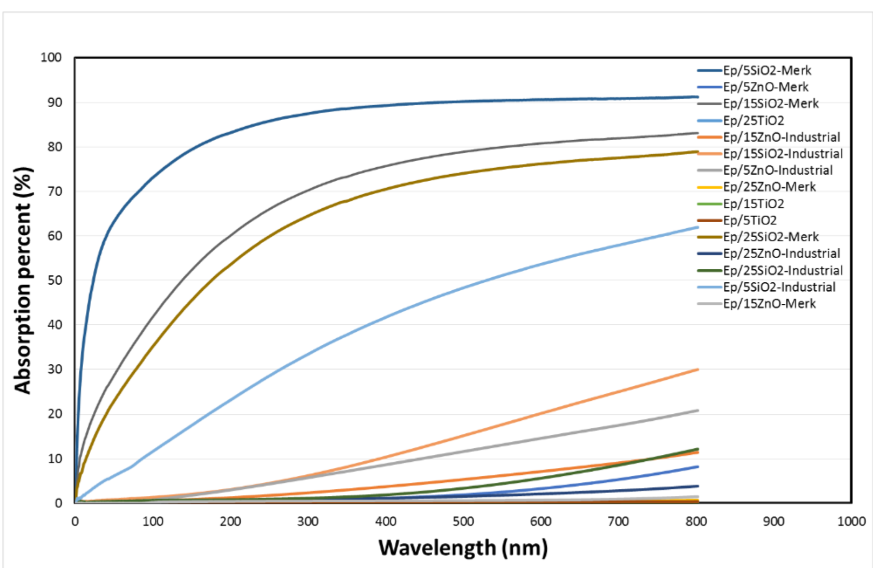


Fig. 2. The result of transparency test

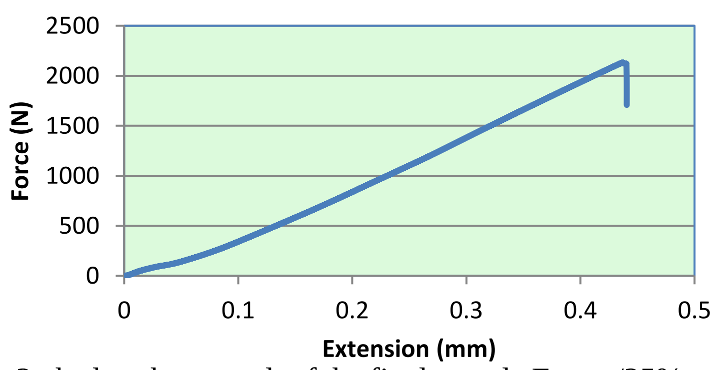


Fig.3. the lap shear result of the final sample Epoxy/25% nano SiO2(Merk)

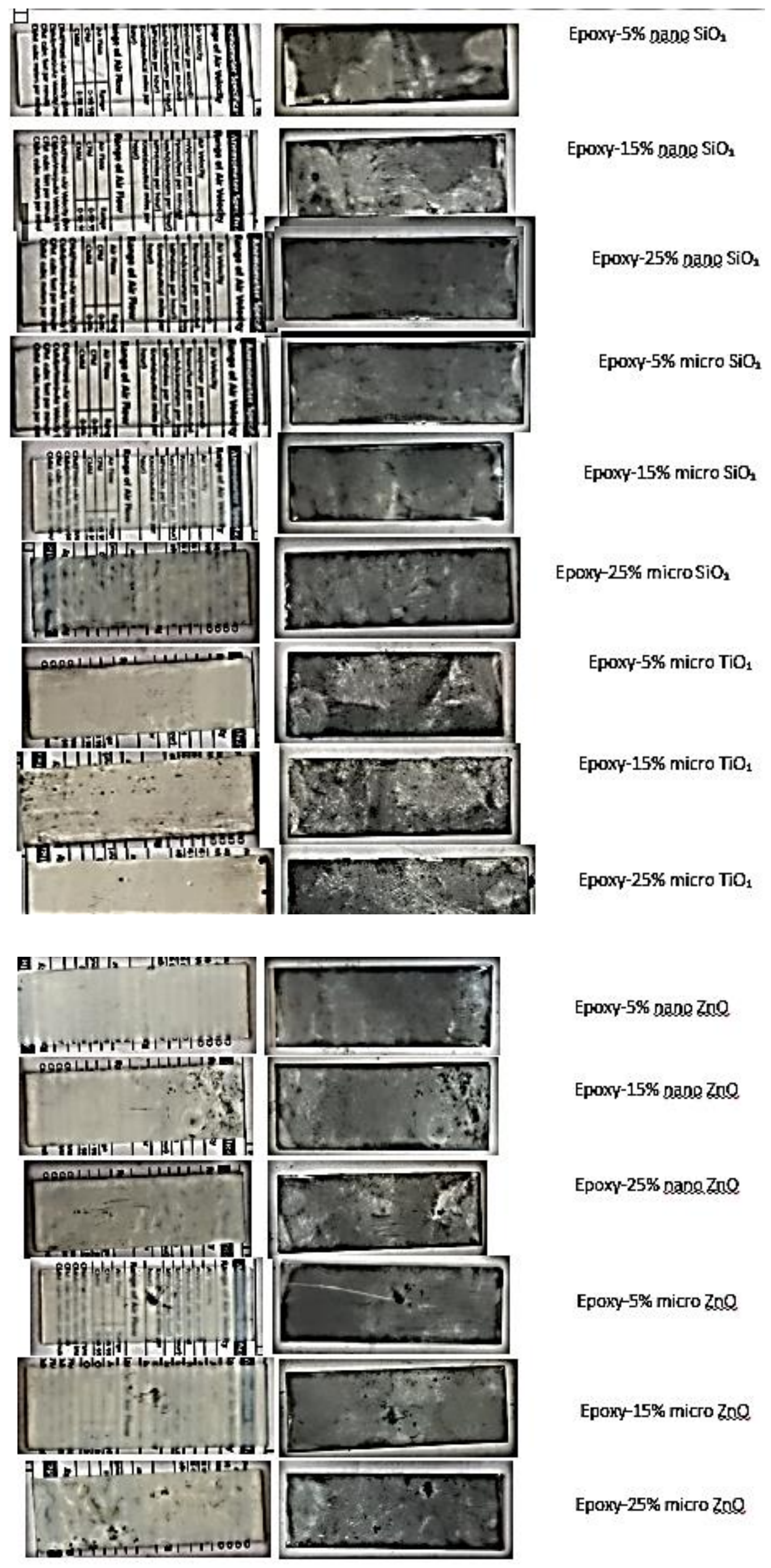


Fig.4. The result of self-cleaning test

Conclusions

Polymeric coatings can perform better than ceramic coatings in construction floors because they are cheaper, have an integrated coating, are transparent, it is easy to pattern on them, and they have better mechanical properties such as impact resistance. But to increase the self-cleaning properties of these coatings, it is better to use oxide particles such as TiO2, ZnO, SiO2, and carbon... as fillers. In addition, nano-sized particles can be used to increase the transparency of the coating. In order to increase the resistance of the coating to UV rays, epoxy polymer and anti-UV fillers such as TiO2 and graphite can be used. The results showed that the effect of self-cleaning is greater in epoxy reinforced with Merck nanosilica particles. This showed that the self-cleaning effect is better on hydrophilic surfaces than on hydrophobic surfaces. In terms of strength and adhesion, the epoxy reinforced with Merck nanosilica particles has been better than all samples. In terms of transparency, nanosilica creates a very transparent surface. Therefore, the use of Merck amorphous nanosilica particles is suggested for self-cleaning and transparent coating.

For coating applications on concrete substrates, silica is the best choice because it is present both in the resin composition and in the concrete substrate, and these allow for better bonding. Nanoforming of silica particles can also increase self-cleaning (with hydrophilic mechanism) and transparency and strength of concrete.

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