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## Preparation of Superhydrophobic Polypropylene Membrane Using Dip-Coating Method: The Effects of Solution and Process Parameters

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## SCH Technologies

Conformal Coating Services, Equipment,  
Technical Support & Humiscale Materials.

### DS101 Conformal Coating Dip System

#### Overview

Automated Dip Coating is one of the most efficient methods for application of conformal coatings and is excellent for all volume production whether large or small.

The process of dipping a circuit board into a conformal coating material contained in a tank ensures complete coverage, underneath components and around difficult large 3D boards and there is no over spray or under spray.

#### Specification

The DS101 Conformal Coating Dip System is a precision built, floor standing, conformal coating dip machine for medium to high volume batch processing of printed circuit boards.

Operating completely on compressed air and utilizing an air over spray system, the DS101 offers a high degree of control and total precision required to meet controls above a wide range of conformal coatings to be correctly coated and an unparalleled repeatable process.

Using entirely pneumatic, the machine is able to use both flammable materials, and the automatic dip cycle process provides a smooth immersion and withdrawal rate which eliminates air bubbles and ensures an even film.

#### Standard Features

- A pneumatically driven control & pump system operating from a single air inlet to meet the most demanding needs.
- Front-mounted control panel for easy operation.
- Control panel with touch screen display.
- Multiple horizontal support rods on dipping arm.
- Transparent doors fitted for minimal exposure to operator.
- Compatible with solvent, silicone and water based coatings.
- Flow cup and stop watch for material viscosity control.
- Full immersion bath and sight glass.
- Front and rear cable management.
- Rohs compliant system.



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Surface & quot; Coatings Technology. 2006; 200 (12-13): 3690-3697. doi: 10.1016/j.surfcoat.2004.10.001https://doi.org/10.1016/j.surfcoat.2004.10.001 17 SHIBLI SM, Dilimon vs. Effect of fesphor content and the reinforcement of TiO<sub>2</sub> in Ni-P electrometerating plaques for the reaction of the evolution of the hydrogegen. International Journal of Hydrogen Energy. 2007; 32 (12): 1694-1700. doi: 10.1016/j.ijhydene.2006.11.037https://doi.org/10.1016/j.ijhydene.2006.11.037 18 Zhao L, Bram M, Buchkremer HP, Ståfver D, Li Z. Preparation of Microfiltration membranes compound TiO<sub>2</sub> by the whole of wet dust spray. Journal of Membrane Science. 2004; 244 (1-2): 107-115. DOI: 10.1016/j.memsci.2004.07.010https://doi.org/10.1016/j.memsci.2004.07.010 In this context, this work was aimed at evaluating the production of coatings composed of nose reinforced with titania nanoparticles produced by immersion in aqueous suspensions of ni-tio2 mixtures without additives. Everyone was used a native dust from size micron (T110, Inc, Canadave) and an suspension of Nanotitania (Aerodisp W 740x, Degussa-Evonik, Germany) with average particle size of 2.5  $\mu$ m and 40 Nm and densities of 8.7 and 4.2 g.cm<sup>-3</sup> respectively. The aqueous suspensions of mixtures Ni/TiO<sub>2</sub> with concentrations of 1.0, 3.0 and 5.0 vol.% (0.5, 1.5 and 2.5 wt%, respectively) of Nanotitania were prepared for the sys JA JA aicnereH-zehcn;AS 22seroetna soidutse n<sup>o</sup>AgeS .adazinoed auga odnazilitu %.lov 03 ed sodinetnoc AJ, Nieto Mi, Moreno R, aqueous colloidal processing of nose dust. MATERIAL ACT. 2001; 49 (4): 645-651. DOI: 10.1016/S1359-6454(00)00347-5HTTPS://doi.org/10.1016/S1359-6454(00)00347-5 The suspensions stabilized with 1% by weight of polyacrylic poliacrícil Duramax D-3005, Rohm and Haas, Haas, USA UU.) Add tetramethyl ammonium (TMAH) Hydrix to pH 10 to avoid dust degradation. The suspensions were prepared by ultrasound mixture using a Sonication probe of 400 W (Dr. Hielscher U400, Germany) for 3 minutes and stirring more than 1 h. The re -olical characterization was performed using a RS50 rev It was measured in controlled speed conditions that use a medical program in three stages; First a linear increase in the cutting rate from 0 to 1000s-1 in 3 min; A plateau at the maximum cutting speed (1000s-1) for 30s, and a decrease at zero cutting speed in 3 min. Commercially available leaves with AISI 1020 steel carbon content were used as coating substrates. The carbon steel lamina microstructure used as substrate material from the Ni-TiO<sub>2</sub> compound lay Grain that comprises a predominantly ferritic matrix with a few perlite colonies in grain nits with a random distribution. Figure 1 Steel sheet substrate before any technical treatment. Individual Ni-TiO<sub>2</sub> coatings were obtained by immersing a 10 mm  $\times$  1 ... s-1 withdrawal rate. Each layer formed after 24 hours in the air to ambient. Green samples were sintered under the argument atmosphere AR/5% H<sub>2</sub> using a two -step tumical treatment, with a first ramp of ambient temperature at 500 °C in 40 minutes to allow the exhaustion of defloculants and a second step From 500 °C to 900 °C in 1 h. the the microstructure microstructure of the sintered bodies was observed by optical and scanning electron microscopy SEM (Leica DM4000M, Germany, and Phillips XK30, respectively, Netherlands). Sintered samples were observed on polished surfaces after chemical etching (Nital reagent). Present phases in the composite coating layer were identified by X-ray diffraction using a Xc $\ddot{\text{A}}$ AAPert (Philips, Netherlands) apparatus with a Cu ( $\ddot{\text{A}}$  = 1.54  $\ddot{\text{A}}$ ) target and a Ni filter at 0.02 $\ddot{\text{A}}$  $\text{Å}$  (2 $\ddot{\text{A}}$ ,  $\text{Å}/\text{s}$ ) scanning speed. For analysis at different depths, the material was removed using fine sandpaper (1200 particles per square). Vickers hardness was determined for the coating and matrix samples using a microdurometer (Shimadzu HMVc $\ddot{\text{A}}$ A2, Japan). The results were obtained from an average of 10 measurements. Results and discussions Figure 2 shows the flow curves obtained from the rheological measurements of the suspensions with a solids content of 30 vol.% and different concentrations of TiO<sub>2</sub>. The results show that the suspensions have a pseudoplastic behavior with the presence of a negligible yield stress, which indicates that a very good dispersion condition. Another important feature is the absence of thixotropy, which allows us to assume that the deflocculation process has been successful to prevent attraction interactions (van der Waals forces) among the particles. These results are characteristic of well-dispersed suspensions with high solids concentration. Figure 2 Flow curves of 30 vol.% suspensions of Ni-TiO<sub>2</sub> mixtures with different TiO<sub>2</sub> contents (vol.-%). From the flow behavior the influence of the concentration of nanoparticles of titania on the viscosity of the suspensions can be drawn, as shown in Figure 3 for viscosity values taken at a shear rate of 50s-1. Observing the figure it is noted that increasing amounts of TiO<sub>2</sub> nanoparticles lead to a square root increase of the viscosity values. The viscosity values increase can then be attributed to the lack of between the ammonium polyacrylate and the organic components of the titanium sopenion components. These nanoparticles remain in the liquid medium, promoting the thickening of the sopenion, as it increases the concentration of nanoparticles. Figure 3 apparent viscosity of Ni-TiO<sub>2</sub> mixing sopenions with different tio content2. steel sotrates were covered in immersion with these sopenions and were further syntered to 900 °C/1 h. after sintering, nanostructured coatings were obtained. homogeneous coatings were obtained without cracks with a relatively high porosity (Figure 4) in which titanium nanoparticles are distributed very well around the surface of the particles of neither. microstructure can be divided into three well-defined regions as shown in figure 5. the outer surface consists of a porous coating layer Ni-TiO<sub>2</sub>. the second region shows the existence of a connection interface between composite coating and sodium. This presents a clear way for the diffusion of nickel atoms in the grain limits of the steel sotrate during sinterization. The maintenance of the sample for growing times in the furnace allowed nickel atoms to penetrate into the iron crystal network that formed the third region of the microstructure. Figure 4 microstructure of coatings composed of Ni-TiO<sub>2</sub> to different increase. (a, b) Ni-1%Ti<sub>2</sub>; (c, d) Ni-3%Ti<sub>2</sub> and (e, f) Ni-5% tiO<sub>2</sub> . Sotrate showed changes n<sup>o</sup>Ácamrof n<sup>o</sup>Ácamrof al adiubirta otartsus led aruturcseorcim al ed apac aremirp al ne onárg ed o±Áamat le ne otneumua nu obuh ,ravresbo edeup es omoC .otseupmoc otneimrbucer led n<sup>o</sup>Ácaciziretnis al ed s<sup>o</sup>Áupsed sovitacifingis Austenita (fe- The formation of this microstructure is due to the torque process of numekery in the iron network, which accelerates by high temperature. The nose is a gammagene element that allows the presence of austenite at room temperature. In addition, the lower layers of the microstructure also underwent changes due to the migration of nose to steel. Austenite can absorb carbon utomos in its crystalline structure around 2.0WT%. This means that Perlita colonies dissolve free carbon migrate to the surface and saturate the austenite. Consequently, an intermediate ferrite region (FE-'±) and a ferrite-perlite combination that composes the original ASM Steel1919 combination can be observed. Metal Manual - Alloy phase diagrams. [S.L.]: ASM International; 1992. v. 3., 2020 Chiaverini V. A $\ddot{\text{A}}$ f $\ddot{\text{A}}$ sos and molten ferros. 6th ed. S $\ddot{\text{A}}$ f $\ddot{\text{A}}$ f or Paulo: Abm; 1988 .. The high viscosity of the Ni-TiO<sub>2</sub> suspensions influenced adhesion during coating formation. This effect is shown in Figure 6. Despite its high porosity, the coatings with concentrations of nanopartars of up to 3.0% Vol.% Showed a good adhesion to the substrate (Fig. 6 (a) and (b)). However, the addition of 5.0% volunteer of the nanopartáculas led to a bad adhesion and the layer takes off (Fig. 5 (c)). This lack of adhesion can be explained mainly due to the greater viscosity of the suspension of TiO<sub>2</sub> Ni-5%that leads to thick more coatings and a more piping drying, which affects the anchor on the surface of the steel. Figure 6 Influence of the content of Nanotitania in the adhesion of the coating and the final porosity of the Ni-TiO<sub>2</sub> compounds. (a) Ni-1%TiO<sub>2</sub>; (b) Ni-3%TiO<sub>2</sub>; (c) Ni-5%TiO<sub>2</sub> and; (d) Porosity evolution according to the content of Nano-TiO<sub>2</sub>. The of microdorness were carried out in different regions of the microstructure: within the coating and in the With the substrate. Table 1 shows the correlation between the profile of the microdura values and the Titania content in the Ni-TiO<sub>2</sub> compounds for the three different regions of the microstructure after the sintering. The first column presents surface measurements where the coating is located. It is evident that the increase in values is due to the growing concentration of nanoparticles, since the coating has high porosity and influence of this factor is already being considered in medicine. The second column refers to the intermediate layer adhered to the substrate. The results show that there was a tendency to the hardness to be reduced by increasing the Titania content. This can be explained by correlating the amount of coverage provided to the nanopartáculas on numel particles. These results suggest that the higher the concentration of nanoparticles promotes a més thick nanotitania coating and, consequently, the lowest rate of nose to diffuse diffuse in the carbon of the steel matrix. Finally, the results obtained for the substrate show that it was not affected by the compound coating. Table 1 Vickers microdorness values of Ni-TiO<sub>2</sub> compounds. To identify the phases present in the microstructure, the sintering samples were analyzed by diffraction of X -rays following this methodology: first, the superficial layer scanned and some removal of material was eliminated by grinding and new scans were made. The results are shown in Figure 7. Figure 7a shows all grouped diffractograms. The peaks of faith and do not mix between if they are very close. The sintering process promoted the consolidation of compound coating and performs a mechanism of homogenization and formation of intermediate phases. First, in the first layer, the peaks identified themselves ocirt©Ámoiuqetse ocirt©Ámoiuqetse nu ed n<sup>o</sup>Ácamrof al ,otartsus le y otneimrbucer le erte ,roirefni n<sup>o</sup>Áiger anu nE .)B7 arugif( 3INEF leuq $\ddot{\text{A}}$  ne ocir ocil;Átemretri otseupmoc nu y orup leuq $\ddot{\text{A}}$  rich in iron, Fe0,64Ni0,36 (Figure 7c), which is not present in the equilibrium phase diagram can also be identified. With more rectified, only Fe peaks were observed (Figure 7d). Finally, pure nickel peaks show a slight enlargement. This can be attributed to the formation of a solid substitute solution of the migration of iron atoms to the crystalline jealousy of nickel. Figure 7 X-ray defraction. a) Full sample; b) surface coating; c) second layer; and d) Substrate. Conclusions A study was carried out on the process of coating low carbon steel with Ni-TiO<sub>2</sub> composite by colloidal. The results obtained from the reological behavior showed that the viscosity of the suspensions increases in the presence of nanoparticles. The final microstructure obtained was divided into three regions: the coating showed the TiO<sub>2</sub> nanoparticles covering the Ni particles. The formation of an interface that includes Fe-Ni was formed during sintering. In this case, nanoparticles promote a reduction of the diffusivity of nickel atoms to the substrate during the sintering passage. In the third region, that is, the substrate, the observed formation of a layer of thick grains suggests that it is made up of austenite. This region has absorbed the carbon contained in the perlada microstructure of steel, changing the final microstructure of the substrate, which shows thick grains, a fried region and finally the presence of perlite. The value of the microhardness obtained has changed slightly between the different regions. The coating obtained the lowest results, the substrate showed intermediate values similar to those of non-coated substrates, while the higher values were obtained in the interface, which relates to the formation of a compound of the solid substitutional solution Fe-Ni. This work has been supported by CNPqNational scientific and technological development, Brazil). Authors greatly enormously .R ,oneroM ,D ,aztoH ,S rakradnahB ,NA nielK, BJ oteN seugirdoR ,EL .rJ arieiV 51 .6981-0981 :)6( 98 ;6002 .yteicoS cimareC naciremA al ed atsiveR .sasouca senoisnepsus in" 3O2lA ed retaFÁreH JA aicnereH-;A fÁS 41 241.20.7002.cosmarecruej.j/6101.01/gro.iod//:sptth»Á fÁ241.20.7002.cosmarecruej.j/6101.01:iod .4424-1424 :;31 72 ;7002 .acim;ÁreC ed aeporuE dadeicoS al ed atsiveR .acit©Árofortcele n<sup>o</sup>Áciscoped rop sadamrofnoc salul©Ác-imēS ZSY -;â IN/ZSY .tM remoloC ,JA aicnereH-retaFÁS ,R oneroM ,B irarreF ,P afÁcraG 31 400.30.8002.mehcelej.j/6101.01:iod .52-71 .026-916 ;8002 .acitÁlanaortcele acimÁuq ed lanruoJ2 .saciñÁgro saluc©Álon sa±Áeupep ed acitÁlatacortcele n<sup>o</sup>Ácadix o arap sotseupmoc senoiserP" -;â P - -;â iN odarutcurtseiN .AM mihar ,BH nassah ,AA LAA 21 11 .5991 ;rekkerD lecraM :kroY aveuN .de a2 .n<sup>o</sup>Ácaciziretnis y acim;Árec ed otneimasecorP .nM namahaR 01 .801-79 :102 ;1991 .sadagled sadil<sup>3</sup>ÁsalucÁleP .leg-los n<sup>o</sup>Áisremni ed otneimrbucer led latnemadnuF .SC yelhsA ,JA druH ,CG eyrf ,JC reknirB 9 8 900.40.5002.cosmarecruej.j/6101.01/gro.iod//:sptth»Á fÁ900.40.5002.cosmarecruej.j/6101.01:iod .2122-5022 :)21( 62 ;6002 .acim;ÁreC ed aeporuE dadeicoS al ed atsiveR .leuq $\ddot{\text{A}}$  ed sotartsus ne DPE y rigremus IA odinetbo odinetbo etaoc le noc ;Áudarg es animalA-lekciN .R ,oneroM ,JA aicnereH-zebmuFÁS ,B irarreF 7 6 900.50.7002.lostyrcnonj.j/6101.01/gro.iod//:sptth»Á fÁ900.50.7002.lostyrcnonj.j/6101.01:iod .3562-6462 :)72( 353 ;7002 .sonilatsirc on sodil<sup>3</sup>Ás ed atsiveR ." loS rop sadaraperp 20IS/N ed salucÁlep sal ed arutcurtsE .A esrevarT ,V ucserodoeT ,GM nihcnalB ,B tunaC 5 4 3 2 .2002 ;naikebluG etsuolaC o fÁ fÁSÁfÁaaredef .MJ arierreF 1 .3102/110A otceyorP ,.3102/17<sup>9</sup>ÁcÁN/SPAF/QPNC/SEPAC/ITCM/CEM( EVP etnatisiv laicepse rodagitsevn le arap saretnof n<sup>o</sup>Áicarepooc ed amargorp led ocram le ne sapac sal ed oreicnanif oyopa LE ed ed larutcurtse y acig<sup>3</sup>Áloer nanocomposites produced by aqueous colloidal processing. 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