nanoresins

TAN US-002a: Comparison of various metal oxide nanoparticles grades with Nanocryl products
Part 2: Chemical Resistance

Account: general study
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All recipe data given in this report is free and may be shared with any customer.

Results Summary

Part two of the present study investigates the effect of various metal oxide nanoparticles suspensions on the chemical resistance of the resulting coatings. The investigation has been carried out using the same test specimen that have already been prepared in TAN-US-002. Please refer to this study for introductory remarks and basic sample preparation information. The recipe data is again given below.

The following results have been obtained:

- Chemical resistance against bases like sodium hydroxide is generally decreased upon addition of Al_2O_3 or SiO_2 nanoparticles, regardless what source. This effect becomes especially visible when high levels of nanoparticles are used and can be explained by the possible interaction of the metal oxides with strong bases.

- Resistance vs. Toluene and Acetone on the other hand is increased. SiO_2 nanoparticles seem to show superior resistance to Acetone vs. Aluminum oxide nanoparticles; however this finding might be inconclusive.

- Resistance towards Gasoline, Alcohols and Acids remains unchanged upon addition of metal oxide nanoparticles.

- Resistance towards Trichloroethylene, a chemical widely used in industrial laundry processes is decreased upon nanoparticle addition.

Recipes:

It is the scope of this study to directly compare the Grade C (Al_2O_3/HDDA) with Nanocryl C140 (SiO_2/HDDA) and the Grade E (SiO_2/solvent) with Nanopol XP 1184 (SiO_2/solvent) at two different solids addition levels. Additionally the effect of the slip additive BYK 3570 should be investigated.

Table 1 contains the coatings formulations that have been used. The basic control coating consists of a simple mix of Sartomer SR 933 (Dipentaerythrolpentaacrylate) and HDDA initiated by a Ciba Irgacure 500 photoinitiator.

Table 1: Coatings formulation recipes

Ingredient [parts]	02/01 control	02/02	02/03	02/04	02/05	02/06	02/07	02/08	02/09	02/10
SR 933	60	60	60	60	60	60	60	60	60	60
HDDA	67	51	0	60.2	38.3	67	67	67	67	60.2
Grade C -Al2O3/HDDA		23	95.7							
Grade E -SiO2/solvent						21.5	89.5			
Nanocryl C140-HDDA				13.8	57.4					13.8
Nanopol 1184-solvent								13.8	57.3	
BYK 3570										0.4
Photoinitiator I-500	5	5	5	5	5	5	5	5	5	5
Total pts. excl. solvent	132	139	161	139	161	139	161	139	161	139
Total particles parts	0.0	6.9	28.7	6.9	28.7	6.9	28.6	6.9	28.7	6.9
Total particles %	**0.0**	**5.0**	**18.0**	**5.0**	**18.0**	**5.0**	**18.0**	**5.0**	**18.0**	**5**
xlinkable material pts.	127	127	127	127	127	127	127	127	127	127
I-500 per Xlink %	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9

Table 2: Coatings formulation recipes – gross batch amount 600 g

Ingredient [g]	02/01 control	02/02	02/03	02/04	02/05	02/06	02/07	02/08	02/09	02/10
SR 933	272.7	259.0	224.0	259.0	224.0	234.5	162.5	246.9	190.2	258.2
HDDA	304.5	220.1	0.0	259.9	143.0	261.9	181.5	275.7	212.4	259.1
Grade C -Al2O3/HDDA		99.3	357.3							
Grade E -SiO2/solvent						84.0	242.4			
Nanocryl C140-HDDA				59.6	214.3					59.4
Nanopol 1184-solvent								56.8	181.6	
BYK 3570										1.7
Photoinitiator I-500	22.7	21.6	18.7	21.6	18.7	19.5	13.5	20.6	15.8	21.5
Total g excl. solvent	600	600	600	600	600	543	435	572	509	600
Total particles %	**0.0**	**5.0**	**18.0**	**5.0**	**18.0**	**5.0**	**18.0**	**5.0**	**18.0**	**5.0**
xlinkable material g	577.3	548.6	474.1	548.6	474.1	496.4	344.0	522.6	402.5	547.0
I-500 per Xlink %	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9

Introduction

Sample preparation and testing procedures

Please refer to TAN-US-002 for a detailed description of the basic coating and test specimen preparation.
To test for chemical resistance the following procedure was applied:

- standard 4x4 coated test panels were used acc. to TAN-US-002.
- approx. 3 oz. (100 ml) of the fluid to be tested was filled in a glass vial having a 0.5" diameter outlet. The glass vial was sealed with a cotton-wool ball to prevent leaking of the test fluid.
- after the vial was sealed it was placed on the coating upside-down. The soaked cotton ball should touch the surface of the coating completely.
- the coating surface was visually inspected after 15 min., 45 min., 2 hrs., 4 hrs. and 8 hrs. Every change in visual appearance was considered a failure criterion. No significant change in visual appearance (discoloration, matting, bubbles, etcc..) after 97 hrs was considered as "Pass".

Results:

Table 3 summarizes the test results of the chemical resistance study:

Table 3: Test Result Summary

Test results	02/01	02/02	02/03	02/04	02/05	02/06	02/07	02/08	02/09	02/10
hours until fail P = Pass (>97 hrs)	control	Grade C 5 %	Grade C 18 %	C140 5 %	C140 18 %	Grade E 5 %	Grade E 18 %	XP1184 5 %	XP1184 18 %	02/04+ Si-add.
10 % NaOH	P	8	8	P	8	P	8	P	8	P
50 % NaOH	P	8	8	P	8	P	8	P	8	P
5 % NH3	8	8	8	8	8	8	8	8	8	8
10 % H2SO4	P	P	P	P	P	P	P	P	P	P
Gasoline	P	P	P	P	P	P	P	P	P	P
Ethanol	8	8	8	8	8	8	8	8	8	P
Toluene	8	P	P	P	P	P	P	P	P	P
Trichloroethylene	8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Acetone	4	8	8	P	P	8	8	P	8	P
Propanol	P	P	P	P	P	P	P	P	P	P