



Antistatic coatings for wood-floorings by imidazolium salt-based ionic liquids



A. Roessler^{a,*}, H. Schottenberger^b

^a ADLER-Werk Lackfabrik Johann Berghofer GmbH & Co KG, Austria

^b University Innsbruck, Institute of General, Inorganic and Theoretical Chemistry, Austria

ARTICLE INFO

Article history:

Received 3 August 2013

Received in revised form

16 November 2013

Accepted 21 November 2013

Available online 14 December 2013

Keywords:

Conductive coating

Antistatic

Surface resistance

Ionic-liquids

Radiation-curable

Flooring

ABSTRACT

The tendency to electrostatic charge is at least an unpleasant property, which is unfortunately typical for many floors. Ionic liquids represent a good alternative to overcome the disadvantages from typical antistatic agents like worse leaching behavior and at least haze in the coating. 1-Allyl-3-alkylimidazolium salts have been evaluated as antistatic additives in a UV-curing coating for parquet flooring. 1-Allyl-3-methylimidazolium chloride has been identified to exhibit the highest activity and a minimized leaching. The measured body voltage regarding EN 1815 was below ≤ 2.0 kV and the resistivity regarding EN 1081 below $10^{10} \Omega$. In addition, there is a synergistic effect with conductive and transparent indium-tin-oxide pigment particles.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

The static charge that easily builds up on floors or furniture surfaces by contact and/or rubbing may create the conditions for sparking caused by an electrostatic discharge. This unpleasant and sometimes painful electric shock is not directly dangerous for humans, but can cause fright reactions with consequences and create severe damage for electronic devices. Long term effects on human health are under discussion, but are of high interest especially regarding allergic persons [1,2]. Electric flashover is also known to be a severe hazard in areas where flammable chemicals are handled. In addition, insulation leads to a high tendency for contamination by dust from the atmosphere which is attracted by static electricity.

UV-curable coatings for wood products were first developed more than 30 years ago to replace solvent-borne nitrocellulose lacquers and alkyd coatings. Today, a wide variety of wood products including panels, doors, pre-assembled furniture and parquet flooring are being finished with UV-curable fillers, stains, sealers, and topcoats. UV coatings are well known for their superior durability, chemical and stain resistance, as well as their many benefits for production facilities like faster production rates due to

immediate handling and packaging, as well as significant reduction or complete elimination of VOCs [3]. However, common UV-curing polymer binders used in wood coatings are insulators and does not intrinsically have anti-electrostatic abilities, in particular under dry conditions. In addition, due to recently demanded optimizations with respect to scratch- and abrasion resistance, an extra decline in antistatic properties of parquet floorings had to be faced [1].

Therefore, there is an increasing demand to provide coatings with conductive and antistatic properties. Many solutions for this problem have been described in literature [4]. However, hardly any of them has no severe disadvantages due to incompatibilities at higher concentrations [5], discoloration, or even reduced transparency (e.g. due to added carbon black, carbon fibers [6], metal powders or metal fibers [7]). The antistatic effect of salt-like quaternary surfactants, brought about by the equilibrium moisture adsorbed on the surface, represents the state of the art, especially in transparent systems. However, sufficient antistatic performance is not achieved under low humidity and the surfactant is removed by rubbing back and forth or washing out [4]. Transparent conductive oxide pigments based on tin, zinc or indium [8] with perfect long-term properties have found only niche applications for cost reasons.

Ionic liquids (ILs), preferably representing salts which are liquid at room temperature (RTILs), had an exponential development in the last years [9]. They have also been reported to be effective anti-electrostatic agents on plastics [10] and wood [11].

* Corresponding author. Tel.: +43 5242 6922 714; fax: +43 5242 6922 309.

E-mail address: albert.roessler@adler-lacke.com (A. Roessler).

In this study, tailor-made UV-curable methyl-imidazolium based ionic liquids have been screened for their potential as anti-electrostatic additives for UV-curing parquet coatings. Cross-linking the UV-active double-bond containing antistatic component with the UV-reactive binder should minimize the leaching behavior of salt based antistatic auxiliaries.

2. Experimental

2.1. Syntheses and materials

All starting chemicals and solvents required for the synthesis and analysis of the series of polymerizable imidazolium salts have been purchased from Sigma–Aldrich and were used as received. Ethoxylated castor oil (Hydroplat 3037) was purchased from BASF.

2.1.1. Allylated imidazolium salts

Commercial 1-allyl-3-methylimidazolium chloride, CAS registry number [65039-10-3], was purchased from IoLiTec, Germany, or prepared by alkylation of 1-methylimidazole with allyl chloride according to published standard procedures [12]. Commercial 1-allyl-3-methylimidazolium tetrafluoroborate, CAS registry number [851606-63-8], was derived from 1-allyl-3-methylimidazolium chloride [65039-10-3] by extractive anion metathesis according to literature procedures [13,14].

Likewise, commercial 1-allyl-3-methylimidazolium hexafluorophosphate, CAS registry number [861908-20-5], was synthesized starting from the parent chloride salt [65039-10-3] by anion exchange based on previously disclosed methods [13–15]. In an analogous manner, hydrophobic 1-allyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide (triflimide), CAS registry number [655249-87-9] was easily prepared by extractive anion metathesis upon addition of an aqueous solution of lithium triflimide to 1-allyl-3-methylimidazolium chloride in water [13,14,16].

2.1.2. Vinylated imidazolium salts

3-Methyl-1-vinylimidazolium methyl sulfate, CAS registry number [26591-72-0], was prepared by direct quaternisation of 1-vinylimidazole with dimethyl sulfate, as previously described [17,18]. Hydrophobic 3-methyl-1-vinylimidazolium triflimide, CAS registry number [384347-24-4], was accessed starting from aqueous 3-methyl-1-vinylimidazolium methyl sulfate, [26591-72-0], by addition of an aqueous solution of lithium triflimide, whereupon the target compound is separating as a bottom layer from the reaction mixture [19,20]. Zwitterionic 3-(1-vinyl-1*H*-imidazol-3-ium-3-yl)-1-propanesulfonate, CAS registry number [46348-09-8], was prepared by quaternisation of 1-vinylimidazole by 1,3-propanesultone [21].

All physical and spectroscopic data of the ILs used for the experiments were found to be in accordance to reported values [12–21].

2.1.3. Supplementary antistatic pigments

As antistatic agents Antimony-tin-oxide pigment Minatec 60 CM from Merck and 2-butenedioic acid (Z)-ester with 1,2-propanediol mixed with 2-(butylamino)ethanol (Byk-ES 80) from Byk was used.

2.2. Coating formulation, curing, application

The radiation-curable composition was prepared by thoroughly mixing over 15 min 30 wt.% of polyester acrylate oligomer (Laromer PE 44 F, BASF), 22–30 wt.% propoxylated glycerol triacrylate (Ebecryl OTA 480, Cytec) and 20 wt.% of a low viscous trifunctional polyether acrylate (Laromer PO 33 F, BASF). Different amounts of antistatic ILs (0–8 wt.%) were added to the coating after pre-dissolution in the glycerol triacrylate. A 1:1 mixture of

benzophenone and 1-hydroxy-cyclohexylphenyl-ketone (4 wt.%; Additol BCPK, Cytec), 15 wt.% silica matting powder (Syloid 162 C, Grace) and 1 wt.% silicone free defoamer (Byk 052 from Byk) were added as a photoinitiator, matting agent and a defoamer, respectively. A 150 μm thick layer of the resin composition was applied on glass using bar applicators. $3 \times 25 \text{ g/m}^2$ (always with a gel-step between), sanding (Kö 280) and $2 \times 8 \text{ g/m}^2$ (always with a gel-step between) were applied on a calibrated (Kö 180) longstrip steamed beech parquet flooring (220 \times 20 cm) by roller coating with reversible dosing roller (Robert Buerkle GmbH). Each gel-step has been performed by $1 \times 212 \text{ W/cm}^2$ at 10 m/min and curing at the end $2 \times 212 \text{ W/cm}^2$ at 10 m/min light from a mercury lamp using conventional UV equipment (IST METZ GmbH).

2.3. Measurement

2.3.1. Electrostatic properties

Electrostatic tests were performed according to the standard method EN 1815 – assessment of static electrical propensity – resilient floor coverings. This method determines the body voltage generated when a person wearing standardized footwear based on a rubber sole walks on a floor covering. This standard determines the anti-static property for the labeling of resilient, textile and laminate floor coverings according to EN 14041. The measured body voltage must be $\leq 2.0 \text{ kV}$. The test was performed in a climate room at 25 °C and 25% r.h.

The standard EN 1081 (determination of the electrical resistance – resilient floor coverings) specify the determination of the vertical resistance and the surface resistance of a floor covering. This standard determines the static dissipative and conductive properties for the labeling of resilient, textile and laminate floor coverings according to EN 14041. The test was performed in a climate room at 25 °C and 50% r.h.

2.3.2. Dust adhesion

The prepared glass plates were charged by 40 times rubbing a blanket of cotton. Afterwards, the surface was placed 2 cm above a Petri dish with activated char coal for 5 s. The dust adhesion was determined optically.

2.3.3. Leaching test

Leaching was simulated by washing the flooring with water containing 0.2% ethoxylated castor oil (Hydroplat 3037, BASF). 30 ml liquid was applied onto 1 m² and distributed with a brush. After 1 min homogeneous cleaning, water was removed by a dry cloth.

3. Results and discussion

3.1. Screening regarding surface resistance and structure–activity relationship

The homogenous distribution of the antistatic components was analyzed by REM-EDX. Fig. 1 shows the elemental profile for the hexafluorophosphate anion indicating an uniform distribution in the coating formulation.

Based on the 1-allyl-3-methylimidazolium cation several anions were evaluated regarding their antistatic effect. The performance ranking was chloride > bis(trifluoromethylsulfonyl) amide (so called triflimide) > methosulfate > hexafluorophosphate = tetrafluoroborate (see Table 1). Regarding the alkyl chain of the 1-allyl-3-alkylimidazolium chloride, the antistatic effect is reduced with increasing the number of carbon atoms (see Table 1). Surprisingly, the hydrogen functional chloride salt shows a significantly lowered effect as the shortest possible alkyl chain, namely methyl.

Download English Version:

<https://daneshyari.com/en/article/692558>

Download Persian Version:

<https://daneshyari.com/article/692558>

[Daneshyari.com](https://daneshyari.com)