



Fingerprint resistant coatings for stainless steel substrates



Ömer Kesmez^{a,b}, Neslihan Tamsü Sellî^{c,1}, Ayşe Tunali^{c,1}, Esin Akarsu^{a,b}, Murat Akarsu^{a,b,*},
Ertuğrul Arpaç^{a,b}

^a Department of Chemistry, Akdeniz University, 07058, Antalya, Turkey

^b NANOen R & D Ltd., Antalya Technopolis, Akdeniz University Campus, Antalya, Turkey

^c Eczacıbaşı Building Products Co. Vitra Innovation Center, Bozuyuk, Bilecik, Turkey

ARTICLE INFO

Keyword:

Anti-finger print
Tailored surface roughness
Polyurethane
Matting agent

ABSTRACT

In this paper, development of coatings with anti-finger print feature for stainless steel substrates is presented. Coatings with tailored surface roughness are demonstrated which provide these properties. Polyurethane coatings are produced by incorporation of matting agents with different particle size and surface chemistry. Depending on the amount of incorporated matting agents and their particle size, we were able to obtain anti-finger print coatings with the designed surface patterns. Chemical resistance tests of the coatings prove that they are chemically durable to be utilized in daily activities.

1. Introduction

There is considerable interest in keeping the surfaces clean and free of contamination such as fingerprint and dirt. With an increase in the number of electronic devices with touch screens, the demand for anti-fingerprint technology is predicted to increase sharply over the coming years [1]. When these devices are used on a daily basis, unappealing stains are left due to the transfer of sweat, oil and cosmetic materials from the user. This leads to increasing demand for an anti-stain technology.

Surfaces with anti-stain or anti-fingerprint property maintain cleaner surfaces longer, i.e. self-cleaning, and are also easier to clean which preserves aesthetic appearance and saves in maintenance cost [2]. Many studies have demonstrated anti-fingerprint coating on the surface of diverse materials [3–7].

In previous studies, anti-fingerprint coatings contained perfluorinated compounds. Since coatings comprising perfluorinated compounds possess low surface energy, the surface repels possible contaminants and prevents their transfer from the fingers of the user of the device [8–13].

A second way to achieve this objective is by a physical approach, in which a surface is so roughened that the contact between the surface and the user finger is minimized [14]. Since the perfluorinated compounds are not environmentally friendly the second method is preferred. In this study our objective is to develop anti-fingerprint coatings by tailoring the surface roughness.

In this paper, we report on environmentally friendly anti-fingerprint coatings with tailored surface roughness, which are obtained by the incorporation of matting agents into a fluorine-free polyurethane matrix. The main focus of the study is to investigate the correlation between anti-fingerprint performance with the particle size and the amount of matting agents. In addition, the coating must meet the durability requirements from mechanical and chemical perspective.

2. Materials and methods

2.1. Composition design

The precursors for the polyurethane coatings were Desmophen 651 MPA/X, a polyester resin with hydroxyl end groups, and Desmodur N75, an aliphatic polyisocyanate resin, both of which were kindly supplied by Bayer Material Science. Dibutyltin dilaurate (DBTL, Sigma Aldrich) was used as condensation catalyst; butyl acetate and ethyl acetate (Sigma Aldrich) were solvents to adjust the viscosity and the solid content of coating solutions. To achieve specific surface roughness, silica based matting agents, Acematt OK 607, Acematt OK 412 and Acematt TS 100 (Evonik Resource Efficiency GmbH) with average particle sizes of 4.5 μm, 6 μm and 9.5 μm respectively, were incorporated into the coatings. Their concentration was 1%, 3% and 5% by weight based on the total solid content. Acematt OK 607 and Acematt OK 412 are fine-grained wax after-treated precipitated silica; and Acematt TS 100 is fumed silica that is not surface treated. The

* Corresponding author at: Akdeniz Üniversitesi, Fen Fakültesi A-Blok, Kimya Bölümü, Dumlupınar Bulvarı, Kampüs, 07058 Antalya, Turkey.

E-mail address: akarsu@akdeniz.edu.tr (M. Akarsu).

¹ Eczacıbaşı Yapı Gereçleri, Vitra İnovasyon Merkezi, Eskişehir Karayolu üzeri, 4.Km 11300 Bozüyük, Bilecik.

Table 1
The designation and composition of coating systems produced.

Sample designation	Acematt OK 607, % in solid content	Acematt OK 412, % in solid content	Acematt TS 100, % in solid content
4M:1C	1%	–	–
4M:3C	3%	–	–
4M:5C	5%	–	–
6M:1C	–	1%	–
6M:3C	–	3%	–
6M:5C	–	5%	–
9M:1C	–	–	1%
9M:3C	–	–	3%
9M:5C	–	–	5%

coating systems produced are described in Table 1 where the solid content of all coating solutions was set to 10% by weight.

2.2. Preparation of coating solutions and their application

In the first step, Desmophen 651 MPA/X was added to a mixture of solvents along with 0.3% of DBTL and stirred until a homogeneous solution was formed. Then, the appropriate amount of matting agent was added and stirred for 2 h at the speed of 750 rpm. The final coating solution, in which hydroxyl-to-isocyanate ratio was kept stoichiometrically at 1:1.15, was obtained after adding appropriate amount of Desmodur N75 and subsequently stirring further for 15 min. The obtained coating solution was applied on previously cleaned stainless steel substrate by spraying with air pressured gun. The coating thickness is about 5–7 μm .

2.3. Fingerprint test procedure

Since the fingerprints vary depending on the skin structure, hardness, fat excretion, etc., of the individuals and further complicated by the pressure applied when touching the surfaces, the test results can differ from one person to another. Until now, there is no widely accepted standard test method to properly evaluate fingerprint impressions and residues. Although several studies have attempted to come up with a test procedure [2–4], only the test method developed by Wu et al. for the quantitative measurement of the fingerprint has been found to be acceptable [2]. Therefore, Wu's method was used in order to test the performance of the coatings. The coated surfaces were tested

with the artificial fingerprint liquid identified by Wu et al. The artificial fingerprint liquid was prepared by adding a 1:1 by weight mixture of 1-methoxy-2-propanol (PM) and Hydroxyl-terminated polydimethylsiloxane (PDMS, Mn ~550, viscosity ~25 cst) at the ratio of 20% by weight into the artificial sweat, which comprises of 3 ml/L lactic acid, 5 ml/L acetic acid, 10 g/L sodium chloride and 10 g/L sodium hydrogen phosphate in deionized water. The application of the artificial sweat to the surfaces comprised first cleaning the finger with alcohol, immersing the finger in the artificial fingerprint liquid and then touching the surfaces. Once this liquid dried, the picture of the dried finger print was taken by a digital camera.

2.4. Structural, chemical and mechanical tests

Infrared spectroscopy (ATR-FTIR; Varian 1000 model) was utilized to investigate chemical structure of coating samples. The surface microstructure of all samples was photographed by means of scanning electron microscopy (SEM, Zeiss EVO 50 at 20 kV) attached with an energy dispersive x-ray (EDX, INCA, Oxford Instruments) spectrometer.

Surface roughness parameter, average roughness (Ra) was measured using a perthometer (MAHR-MARSURF-PS-1). Gloss was measured with a gloss meter (Minolta Gloss 268) with a 60° light incident angle on the uncoated and coated surface. Hardness and adhesion of the coated samples were carried out by an Erichsen Hardness Test Pencil 318 and an Erichsen Type 295 multi-cross cutter, respectively. The results of the tests were evaluated according to the ASTM D 3359 standardized test method [15].

Chemical resistance tests of the coatings were performed according to BS EN-14688 standard test method using various different solutions and solvents, these were: 10% (v/v) acetic acid, 5% (w/w) sodium hydroxide, sodium hypochlorite with 5% (w/w) active chlorine, 1% (w/w) methylene blue, 50% (w/w) sodium chloride and 70% (v/v) ethanol. In this method, a portion of test solution is dropped onto the test surface and kept covered with a watch glass at room temperature for two hours. After rinsing the test surface with plenty amount of distilled water, the surface is inspected visually. If the surface is not affected by the respective test solution, it passes the chemical resistance, otherwise it was considered as failure.

3. Results and discussion

The progression of cross-linking of polyester resin with

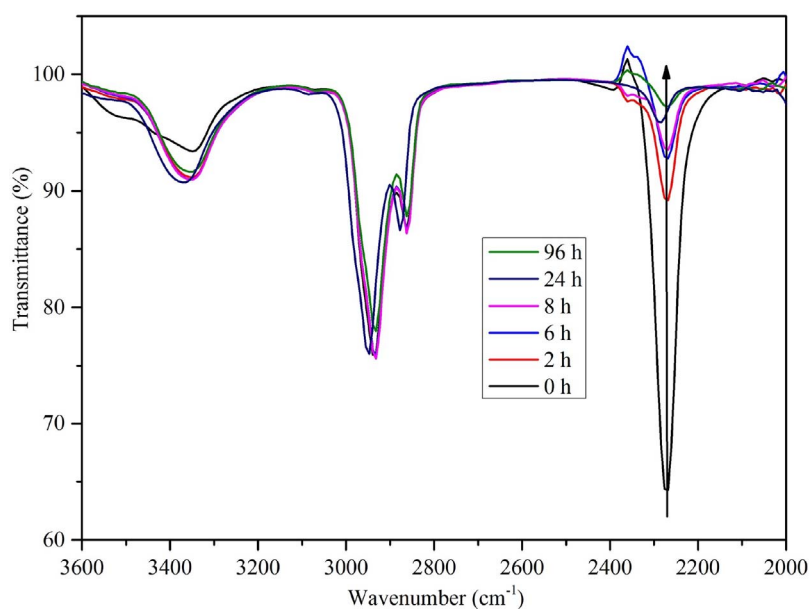


Fig. 1. Infrared spectra of the PU coating at the beginning of deposition and after 2, 6, 8, 24 and 96 hours.

Download English Version:

<https://daneshyari.com/en/article/4999124>

Download Persian Version:

<https://daneshyari.com/article/4999124>

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