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Electric Conductivity of Inorganic Effect Pigment Coated Cotton Textile Using Sol-gel Process

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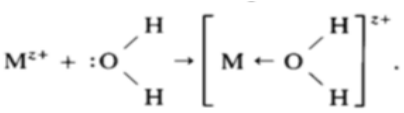
In this work cotton textile was treated with inorganic effect pigment using sol-gel process. The prepared samples were then investigated for the measurement of electric conductivity in terms of surface resistance. The effect of the conductivity of inorganic effect pigment coated cotton textile by sol-gel process will be discussed in this work.

Cotton is one of the cheapest polymers found all over the world. Different surface modifications have been applied on cotton surface to get developed properties of textile surface. These modifications include different processes: from conventional coating to latest sol-gel process. In a sol-gel process, colloidal suspension of particles is applied on applied surface. Surface treatment by sol-gel process has been done by different researchers [1,2]. Silver nanoparticles modified conductive textile with antimicrobial property is prepared by Xue el al. [3]. Varesano, et al. improved electrical performance of wool textile by synthesising of polypyrolle on textile surface [4]. Plasma treatment can be applied to get improved surface characteristics and the conductivity of the textile [5]. Electro-conductive cotton textile has been obtained by treating with graphene/TiO_2 Nano-composite on textile surface [6].

This work is the continuation of authors' previous work [7]. The cotton textile is treated with inorganic effect pigment-binder system in water. Thickener and dispersing agent were added in solution. Following sol-gel process, the coating was done. A thin film of metal oxide was formed by condensation reaction after curing at 130-degree Celsius for 2 minutes. Four effective pigments: Symic C001, Luxan D393, eConduct 421000 and Texmet 5000 have been used in this work. Sol-gel processes is the combined process of the hydrolysis and condensation. In pure water, metal cations (denoted by $\mathbf{M}^{z+}$), are solvated by water molecules. The mechanism of hydrolysis is as following [8-10]:



For inorganic metal, used in this investigation, produce a metal hydroxides in hydrolysis process and later form a metal oxide gel in condensation process.

M-OH + M-OH → M-O-M + H_2O, Here M denotes the titanium or silver.

The aim of the study was to consider this metal oxide film as eclectic conductor and how the metal oxide film affects the surface resistance of effect pigment coated textile, will be compared later part of the study (Figure 1).

The conductivity is the opposite term of resistance. The lower will be the resistance; the higher will be the conductivity. The samples found from the above mentioned way, were then tested for antistatic property by antistatic tester. The coated samples were investigated in terms of surface resistance. MECO MGT-3 antistatic tester was used to measure surface resistance. The results were shown in ohm (Ω). It has very easy procedure to measure. Just two metal parts of tester need to be touched on fabric surface which gives the direct value in ohm. Three attempts were taken for every sample and the highest and the lowest value were counted and averaged for each. All of the results were noted [Table 1]. Relative humidity and lab temperature were recorded 51% and 21 degrees Celsius respectively.

The reference uncoated woven textile shows surface resistance of 1*1010-1*1011 Ω. Metal effect pigment reduces the surface resistance of textile surface. It means the conductivity of surface increases due to presence of metal on coated surface. The Symic C001 is an inorganic effect pigment based on artificial mica containing titanium dioxide. Presence of Titanium transition metal reduces the surface resistance values to 5*108 Ω -1*107 Ω based on pigment concentration. Platelets of glass flakes coated with titanium dioxide, iron oxides, silica and tin oxide, the Luxan D393 coated textile surface exhibits surface resistance in between 2*109 Ω and 2*107 Ω. Copper powders coated with silver, the eConduct 421000 reduces the surface resistance values to 5*109 Ω -1*109 Ω. Silver effect pigment Texmet 5000 did not shows good conductivity as the values remain in a range of 1*1010 Ω and 1*109 Ω.

As metal effect pigment like eConduct 421000 and Texmed 5000 consist of Silver-coated copper and aluminium flake respectively as well as pearlescent effect pigments like SYMIC C001 consists of titanium

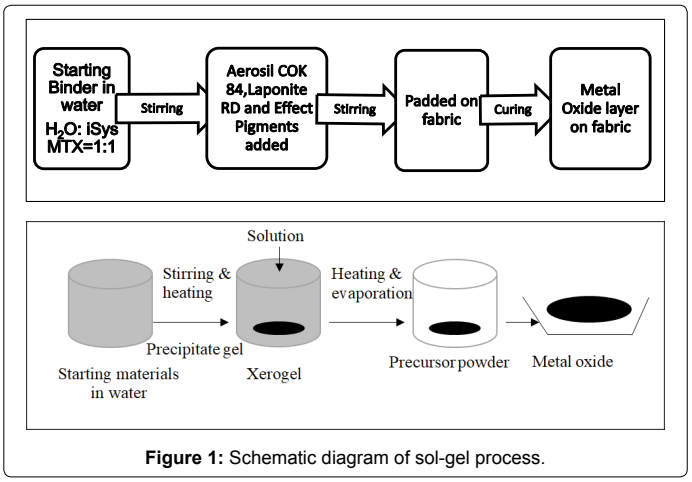


Figure 1: Schematic diagram of sol-gel process.

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Effect pigment	Antistatic value/ surface resistance (Ω)
Reference sample	$1*10^{10}$-$1*10^{11}$
5% Symic C001	1-$2*10^{7}$
10% Symic C001	$2*10^{8}$ -$5*10^{8}$
20 % Symic C001	$2*10^{8}$
5% Luxan D393	$2*10^{7}$-$5*10^{7}$
10% Luxan D393	$1*10^{9}$
20% Luxan D393	$1*10^{9}$-$2*10^{9}$
5% eConduct 421000	$2*10^{9}$-$5*10^{9}$
10% eConduct 421000	$1*10^{9}$-$5*10^{9}$
20% eConduct 421000	$1*10^{9}$-$5*10^{9}$
5% Texmet 5000	$1*10^{9}$-$1*10^{10}$
10% Texmet 5000	$2*10^{9}$-$1*10^{10}$
20% Texmet 5000	$1*10^{9}$-$2*10^{9}$

Table 1: Surface resistance of cotton and various inorganic effect pigment coated cotton textile surfaces.

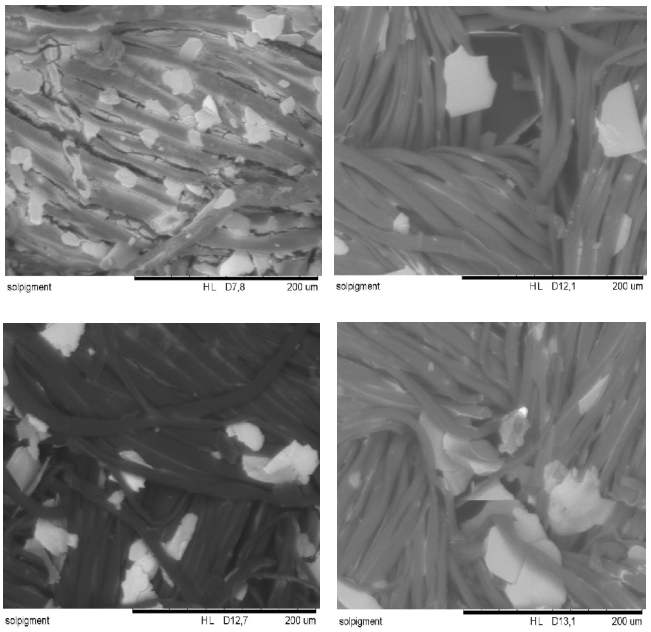

Figure 2: SEM images of sol-gel processed cotton textile: coated with (a) Symic C001, (b) Luxan D393, (c) eConduct 421000 and (d) Texmet 5000 effect pigment [5% pigment concentration, 500 times magnification].

dioxide, they show surface electric conductivity when applied on a textile surface. The surface metal component is responsible for the increase of conductivity, as the metal platelet acts as conductor for transferring the charges. The SEM images show the platelets which work as the electric conductor while coated on textile surface (Figure 2).

The study show that the inorganic effect pigment coated cotton textile surface decreases the surface resistance by increasing the conductivity of the surface. The findings help consideration of surface conductivity for fabric designing and coating technology.

In conclusion, the surface modification of cotton textile with effective pigment will open a new door of conductivity of modified surfaces. In greater extend, it decreases the resistance of treated textile which helps the surface to be more conductive compared to untreated cotton textile.

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