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Air Canada Services Fabric Designing: Self-Cleaning and Antibacterial Approach

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Abstract

In this study the accessories of air Canada first class cabin was designing with material of fabric by using air Canada logo. In fact the logo was redesigned and printed on fabric. The fabric was treated with nano $TiO_2/SrTiO_3$ and it's self-cleaning under UV irradiation was investigated. Also its antibacterial properties was studied and the results was show that the fabric has antibacterial properties and self-cleaning properties. So using this fabric in airplane as accessories (such as glass cover, food cover, and head cover of furniture) has good effect on passengers mind and help to improve the health of passengers and also these can use as environmental friendly materials of Airline services.

Keywords: Nano $SrTiO_3$; Nano TiO_2; Self-Cleaning; Fiber; Antibacterial

1. Introduction

The common biological processes of degradation and discoloration on modern dyes are ineffective because of high degree of aromatic groups in dye molecules. The traditional physical methods such as using active carbon, filtration, reverse osmosis and coagulation are costly; moreover, these methods do not degrade the dye and just change its phase (Janus and Morawski, 2007). In recent years, advanced oxidation processes (AOPs) have been developed to deal with the problem of destruction of dyes in aqueous systems. The researches show that AOPs based on photocatalysts are effective. The benefits of this method are mineralization of organic compounds, no wastewater problem and processing in mild pressure and temperature (Vinu et al., 2010; Chen,

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2009; Foletto et al., 2009; Pouretedal et al., 2009; Wang et al., 2009; Konstantinou and Albanis, 2004).The use of semi-conductors such as TiO_2, ZnO, Fe_2O_3, and CdS as photocatalyst is interesting for the degradation of organic pollution. Due to optical and electrical properties, low cost, high photocatalytic activity, chemical stability and non-toxicity of nano-titanium dioxide, it is used as a common photocatalyst (Xua et al., 2008; Hegde et al., 2005, Azaditehrani et al., 2017). Band gap larger than 3.2 eV causes low efficiency of nano- TiO_2, and the separation of nano-titania from the wastewater after photocatalytic dye degradation which is very difficult due to the small particle size (Wang et al., 2006; Zyoud et al., 2010; Ueda, 2004). Therefore, there is a need to find novel materials with high performance for the use in heterogeneous photocatalysis. The perovskite oxides recognition as photocatalyst has ABO_3 formula; where A is a rare earth metal with a large ionic radius or alkaline earth metal, B is a transition metal with a small ionic radius. Alkali metal acts as the ionic balance (place in A) and the Titanate framework plays the main role in the structure and properties with Ti in the B sites (Boudali et al., 2009; Subramanian et al., 2006; Niishiro et al., 2005). The presence of Sr in $SrTiO_3$ gives more ionic properties in comparison to SrO, and Ti is more covalent in $SrTiO_3$ than in TiO_2, so this causes the reduction of the acidity of Ti ions and increase of covalent property. Thus, bond formation properties might be different with titania and can lead to different photocatalytical reactions (Chang et al,. 2008) .In comparison with other oxidants, the multi-cation oxide of $SrTiO_3$ is more capable of tuning the chemical and physical properties by altering the compositions and also has larger number of photocatalytic sites. The photocatalytic degradation of synthetic dyes using nano-strontium titanate has been reported in less scientific researches (Subramanian et al., 2006; Tsumura et al., 2009; Puangpetch et al., 2008).

In the present study photocatalytic activity and antibacterial properties of viscose fabric which treated with nano $TiO_2/SrTiO_3$ was investigated and these fabric designed for air Canada services.

2. Materials

The bleached plain weave 100 % viscose fabric was with the weft density of 27 yarn/cm and the fabric weight of 125.6 g/m_2. Nano-strontium titanate powder (P.N.517011) with average particle size of less than 100 nm from Sigma Aldrich and nano titanium dioxide powder (Degussa P-25) consists of 80 % anatase and 20 % rutile with average particle size of about 25 nm from Evonik were employed. Sodium hypo-phosphate (NaH_2PO_2) from Fluka as a catalyst and succinic acid ($C_4H_6O_4$) as a cross-link agent from Merck were prepared.

At the first, fabric was washed with distilled water at 80^{o}C for an hour to remove wax and extra materials. Cross-link method was used in order to coat viscose fabrics with nano materials.

Microscopic investigations on fabric samples were carried out using a Philips XL30 scanning electron microscope (SEM). Cured fabrics were cut into 4×3 cm pieces. In order to investigate the self-cleaning characteristics of cured fabrics, colorant stains were created on the samples. Aqueous solution of Direct Green 6 (CI 30295) and Reactive Orange 72 (CI 17754) were used as synthesized colorant stains. The treated viscose samples were stained by 0.1 ml of colorants. After being stained, the samples were exposed to the UV irradiation in order to investigate the photocatalytic activity and also the sample were stained by E.Coli bacteria in order to investigate the anti-bacterial property.

3. Results and Discussion

3.1. Characterization

The SEM image of $TiO_2/SrTiO_3$ nanocomposite is shown in Fig 1. The nanoparticles are seen aggregated at some level with diameter in the range of 20–50 nm. From the Figure, the $SrTiO_3$ particles distributed on the titanium dioxide nanoparticles. It obviously exhibits the good contact between TiO_2 and $SrTiO_3$ nanoparticles.

3.2. Self-Cleaning Property

Self-cleaning performance of the treated viscose fabric were examined by the discoloration of the methylene blue stain on the surface of samples. The diagram in Fig 1 compares the results of spectrophotometery of the treated fabric, exposed to the sunlight. The results acquired indicate that applying of nano materials in fabric finishing led to the significant discoloration of methylene blue on the fabric. Based on the obtained results, the sample treated with the $TiO_2/SrTiO_3$ nanocomposite has the best self-cleaning property.

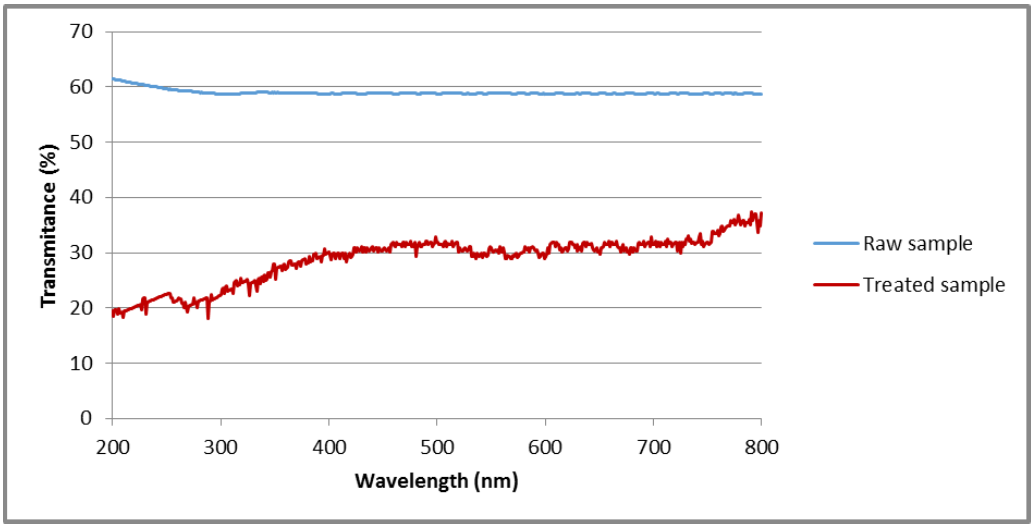

Fig 1 Comparative diagram of self-cleaning performance results of the treated viscose fabrics and untreated sample

3.3. Antibacterial Property

Antimicrobial efficiency of the treated fabric was tested against E. coli bacteria. The E. coli bacterium is a pathogenic micro-organism causing many diseases such as toxic shock, purulence, abscess, fibrin coagulation, and endocarditic. Moreover, E. coli bacterium which causes urinary tract and wound infections is a popular test organism.

Based on the results there isn’t any reduction of bacteria on the raw viscose fabric but, the treated sample with the nanocomposite had the highest antibacterial activity against E. coli bacteria. The antibacterial activity of treated fabric was about 98% for E. coli bacteria. In other words, combining titanium dioxide with $SrTiO_3$ was improved the antibacterial activity of fabric.

3.4. Air Canada Services Fabric Designing

In this part the pillow, dish and napkin ring is redesigned. As we know the arm of Air Canada is a red leaf. This leaf in our designing is present but with some differences. In fact, we redesign the leaf and by redesigning the arm we create creative designs. The tree applicable objects of Air Canada are pillow, dishes, napkin and napkin ring. So in this paper we redesign these objects by fabrics. The specialty of this paper is the designs that are created on special fabrics which has antibacterial and self-cleaning properties. In designing process, mirroring and repeating are used. Finally, the pillow, dish and napkin ring with redesign Air Canada arm which has self-cleaning and antibacterial properties design in order to use in airplane services which give peace of mind to the passengers.

Fig 2 Designing of air Canada pillow, dish and napkin ring

4. Conclusion

In this study, titanium/strontiumtitanate nanocomposites were successfully prepared and used for functional treatment of viscose fabrics. Through SEM images the successful preparation of titanium dioxide/ strontiumtitanate nanocomposite on the surface of the treated viscose sample was verified. Adding strontiumtitanate to titanium dioxide nanoparticles improved some properties of viscose fabrics such as self-cleaning and antibacterial properties.

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