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PREPERATION OF FIRE RESISTANT AND SELF CLEANING NANOCOMPOSITE USING TiO_2, ZnO and SiO_2 FOR TEXTILE APPLICATION.

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ABSTRACT:

In this study, nanocomposite consisting of titanium dioxide (TiO_2), Zinc oxide (ZnO) and Silica nanoparticles (SiO_2) was synthesized for use in fabrics to improve the fire-resistant (FR) and self cleaning property for cotton fabrics to improve the treatment effectiveness and minimize the side effects of the treatment. For FR-treated cotton fabrics, the flame extinguished right after removal of the ignition source with no flame spreading. A noticeable result was that the TiO2/nano-TiO2 cocatalyst had a significant effect on decreasing the flame-spread rate and ZnO, SiO_2 having the good selfcleaning property. Here we synthesis the Fire resistant nanocomposite by wet chemical method. The nanocomposite was then characterized to understand the surface morphology and their chemical structures by SEM, FTIR and UV-Visible spectroscopy which confirmed the nanocomposite formation. The FTIR result shows the absorption peaks for SiO_2-TiO_2-ZnO respectively and the UV-Visible result having the absorption spectrum of SiO_2-TiO_2-ZnO on one main band in the visible region and the surface morphology of prepared nanocomposites was examined by a scanning electron microscope are discussed.

INTRODUCTION:

Clothing is typically made of fabrics or textiles which is worn on buman body. Clothes can insulate against cold or hot conditions, and they can provide a hygienic barrier, keeping infectious and toxic materials away from the body. Clothing also provides protection from ultraviolet radiation also. The main purpose of clothing is to fit human body and be adaptable to its movements. In addition, it also has to protect our human body from the different climatic conditions like cold or hot environments and from skin damage caused by external materials while coming in contact with human body [1]. There are different types of fabrics used for clothing. They are divided as two category based on Natural fabrics and Synthetic fabrics. Some of the natural fabrics are cotton fabric, silk fabric, linen fabric, wool fabric and jute fabric. And some of the synthetic fabrics are Nylon fabric, Demin fabric, Polyester fabric and Velvet fabric. Cotton fabric is one of the important textiles widely used to produce home furnishings, apparel and various industrial products due to its softness, breathability, and capability to absorb moisture [2]. Due to the comfortable, natural, renewable, and environmentally friendly properties of cotton fabric, cotton fabrics are also used in both military and civilian areas [3]. Cotton cellulose undergoes degradation on ignition, forming highly combustible volatile compounds mainly levoglucosan with the propagation of fire causing injuries and fatalities in fire accidents [4]. Easy ignition, rapid combustion and low thermal stability of cotton fabric represent their limitations and weakness in the production of fire protective and high performance textile products. These problems can be overcome by using flame retardants. Flame retardants can be efficiently incorporated into fabrics by several methods like grafting them on the fabrics or by adding them directly in the initial stages of fabric preparation [5]. Mechanical incorporation of the flame retardant additives into cotton cloth is another fast blending technique that can be carried out low cost. Nanotechnology is being used in large number of products such as surface coatings, building materials and other consumer goods. Some of the popular nanotechnology made products such as mortar, bricks, foams, insulations, clay and clay composites, silicate epoxy nanocomposites and cotton fabrics. And few non-buildings such as hydrogels and nanofiber mats are the materials which are all using for decreasing the thermal conductivity of common materials to increase safety [7]. Nanomaterials have created an interest in increasing the efficiency of various properties of materials of interest due to their smaller size and high surface to volume ratio. Among them, Metal oxide nanoparticles are used in various fields like gas sensors, rechargeable batteries, solar cells, antibacterial activity, antimicrobial activity and fire repellent activity [6]. Titanium dioxide nanoparticles are one of the metal oxide nanomaterials have the unique properties of fire repellent character and can be used in cotton fabrics. Titanium dioxide nanoparticles are colourless, non-toxic and tasteless particles which having the property of UV repellent, antibacterial activity, self -cleaning activity, fire repellent and so on. TiO_2 nanoparticles based coating that is applied to many cotton fabrics for increasing the fire retardant activity. These TiO_2 nanoparticles are applied in a layer by layer formation to build an efficient and stainable(check this word) coating that can protect the cotton from fire. A combustible textile is nothing but, a textile material that will ignite and burn easily or the vapours produced during burning are also readily combustible. Some combustible fabrics when used for clothing are potentially dangerous to the wearer. The two important factors which determine rate of combustion in cotton fabrics are the ease of ignition and the flame-spread speed[8]. This study focuses on the effect of deposited TiO_2 nanoparticles as a flame-retardant to create photoactive flame-retarded fabric as this paves way for their use in industrial applications. The two important factors which determine rate of combustion in cotton fabrics are the ease of ignition and the flame-spread speed [9]. This study mainly focuses on the synthesis of fire retardant and self cleaning nanocomposites using TiO_2, SiO_2 and ZnO nanoparticles and the coating techniques, fire retardant and self cleaning test on fabric will be reported in the future report. Here we use ZnO because of the different properties at different nano-morphologies at various synthesis conditions can be obtained, ZnO will act as good self cleaning nanomaterial. Moreover, TiO2 is one of the most extensively studied oxides because of its remarkable flame retardant and self cleaning properties. In past research, ZnO-TiO_2 nanocomposite nanoparticles are widely used for fire resistant and self cleaning applications. Here, incorporation of SiO_2 into ZnO-TiO_2 for nanocomposites formation. Enhancement of Fire resistant property of ZnO-TiO_2 nanocomposite by adding SiO_2 nanoparticles. TiO_2-ZnO-SiO_2 nanocomposites is newly introducing for fire resistant and self cleaning application.

SYNTHESIS:

Take 25ml ethanol and add 5ml of TEOS (Tetra ethyl ortho silicate) and stirr the solution for 10 minutes. After 20 minutes of stirring, add 6ml of ammonium hydroxide dropwise. Here we obtain white turbid solution. Take 50 ml of Isopropanol and add 5ml of Titanium isopropoxide, stir it for 1 hour continuously with certain heat. Cooldown the solution and add 25ml of Conc [9]. Ammonia and 5 grams of Zinc acetate then stir it for 20 minutes. Then add the silica sol with this prepared TiO_2 and ZnO sol and stir it for 1 hour. Here the ZnO, TiO_2 and silica sol is prepared.

CHARACTERIZATION:

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Scanning Electron Microscopy:

The surface morphology of prepared nanocomposites was examined by a scanning electron microscope with an accelerating voltage of 10 kV at High magnification of 5.00 KX. The SEM photographs illustrating the surface morphology of Zinc oxide, Titanium dioxide, Silica naocomposites [10]. The surface of the TiO_2 / ZnO was rather coarse and had many irregular small granules comparing to that, the surface morphology of TiO_2/ZnO/ SiO_2 was similar to that of the TiO_2 /ZnO. However, there are much more fine granules on the surface of TiO2/ZnO/ SiO_2 than that of TiO_2 / ZnO [Fig.1], which might result from the introduction of SiO_2. These results suggested that TiO_2 , ZnO, SiO_2 were formed into a nanocomposite successfully. The surfaces of TiO_2, ZnO become rougher after the SiO_2 reacts with them. Here we can see the rougher surface when comparing to reference figure, this will indicates the presence of SiO_2.

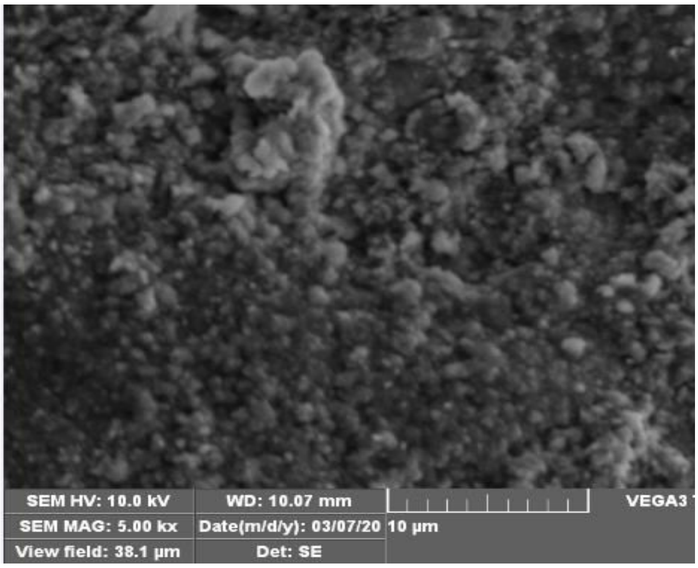

Fig : 1 SEM images of TiO_2/ZnO/ SiO_2 nanocomposites at 5000×

FTIR:

- **There were also two absorption peaks at 1632.13 cm^{-1} and 1393.389 cm^{-1}, corresponding to the Zno and TiO_2 vibrational frequencies [11].**
- In zero-order derivative spectrum the area of reveleant signal was measured [Fig : 2].
- SiO_2 -TiO_2-ZnO composite displayed the characteristic absorption band for Ti–O bond at 621.18-952.83 cm^{-1}.
- The Si-O stretching of Si-OH appears at 908 cm^{-1}. This band overlapped Si-O-Si of condensed silicate. The Si-O-Si bending mode appears at 446 (435) cm^{-1}.

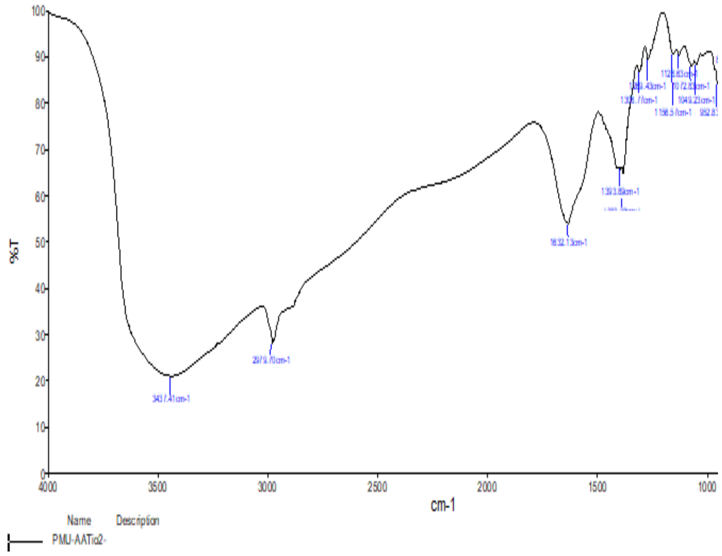

Fig : 2 FTI spectra of the SiO_2 -TiO_2-ZnO Nanocomposites

UV-VIS SPECTROPHOTOMETER :

Ultraviolet-visible (UV-Vis) spectrophotometry technique is used to measure t absorbance across the ultraviolet visible ranges of the electromagnetic spectrum. A UV-Vis spectrophotometer can use this principle to quantify the analytes in a sample based on their absorption characteristics [12]. The absorption spectrum of the SiO_2 -TiO_2-ZnO nanocomposite was characterized by one main band in the visible region (maximum absorption at 325 nm). Where the previous research reports shows the peak of TiO_2-ZnO nanocomposites visible region (maximum absorption at 374 nm) respectively.

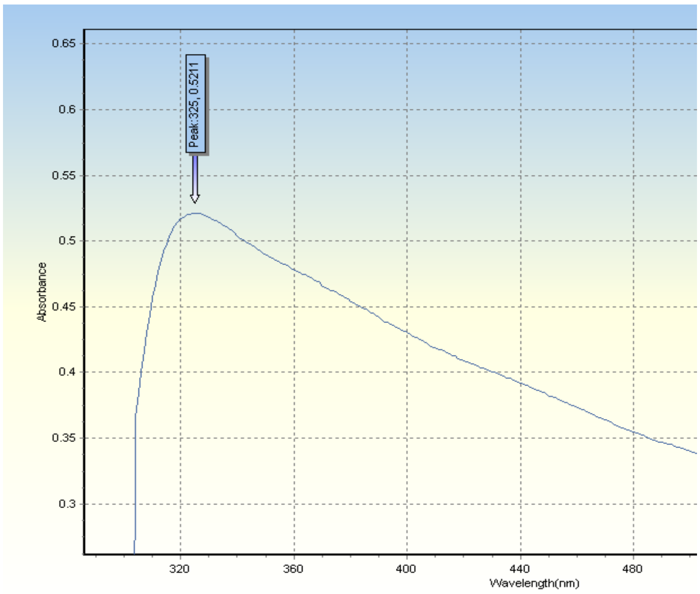

Fig : 3 UV-vis Peak obtained at 325nm.

CONCLUSION:

Here we conclude that the nanoparticles which are having the good fire retardant and self cleaning activity are prepared as a nanocomposites. TiO_2 – ZnO-SiO_2 nanocomposite was successfully synthesized. SEM image confirms nanocomposites formation as the surface is more rougher in TiO_2 – ZnO-SiO_2 than in TiO_2 – ZnO nanocomposite. FTIR characterization confirms the presence of characteristic peaks of TiO_2 , ZnO and SiO_2 confirming nanocomposite formation and UV-vis spectroscopy shows the peak at 325nm for the presence of TiO_2 – ZnO-SiO_2 nanocomposites respectively. And the synthesized nanocomposites are taken for the future testing for cotton fabric. The results obtained in the study can be useful and helpful in preparing a fire retardant and self cleaning fabric using this nanocomposites.

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