ABSTRACT

The main objective of the present work is to develop rice husk derivatives such as activated carbon, nanosilica, Silicon (Si), Silica Aerogel (SA) and mesoporous silica (SBA-15) as UV shielding coating materials for cotton fabric. In order to make them as a suitable candidate for protective coating against UV radiations, the rice husk derivatives were hybridized with polymer and metal oxides. Thus, polyaniline was grafted along with activated carbon or nanosilica over cotton fabric through insitu polymerization approach. In this approach, 3-amino propyl tri ethoxy silane was used as crosslinking agent to hybridize polyaniline with rice husk derivative (activated carbon or nanosilica) and cotton fabric.

Further, various amount of Titania (TiO_2) was used as dopant in minimum quantity with silicon and silica aerogel andvarious amount of ceria was doped with SBA-15 to promote the UV shielding behavior of the rice husk derivates. Subsequently, the optimized metal oxide doped rice husk derivatives were suitably surface modified using silane coupling agents, in such a way to favour the compatibility with cotton fabric. Further, the surface functionalized rice husk derivatives were coated over cotton fabrics through pad-dry-cure method. Tensile strength, elongation at break, tear strength and thermal studies were also performed to study the impact of coating on the basic properties of the cotton fabric. Further, the laundery durability of the treated fabric was also performed to ascertain their retention of UV shielding property after several washing.

Initially, the present work deals with the development of amine Functionalized Activated Carbon (FAC) prepared from bio source rice husk and the same has been used as a UV protective coating material for cotton fabric along with polyaniline network. Thus, different weight percent of both

FAC and aniline were used to develop the FAC coated and polyaniline grafted cotton fabric. The resulting cotton fabrics were studied for their UV shielding property. It is quite interesting to note that the UV shielding behavior of developed cotton fabric has significantly increased with respect to activated carbon and aniline content. To maximize the UV shielding property of cotton fabric, the contents of FAC and aniline were optimized. As a result of optimization, the cotton fabric with 3 wt % FAC and 25 wt % aniline holds UPF of 63.9. These results show that the activated carbon of rice husk and polyaniline coated cotton fabric posses excellent UV shielding when compared to neat cotton fabric.

Anothervaluable biomass product nanosilica obtained from rice husk has been hybridized with polyaniline through grafting and was used as coating material over cotton fabric using 3-amino propyl triethoxy silane as crosslinking agent. In order to optimize the coating percentages of nanosilica and polyaniline, different weight concentration of both sodium silicate and aniline were used to develop the nanosilica coated and polyaniline grafted cotton fabric. The resulting cotton fabrics were studied for their UV shielding property, thermal and basic fabric properties. Cotton fabric coated with 50 wt % of aniline and 0.75 wt % of silica ($S_{0.75}A_{50}C$) affords the highest UPF as 46.2. The result shows that the nanosilica coated and polyaniline grafted cotton fabric posses excellent UV shielding when compared with that of neat cotton fabric.

Subsequently, Silicon (Si) was prepared via magnesiothermic reduction method and Titania in various concentrations was doped on silicon. The obtained Titania Silicon (Ti_nSi) was analyzed for their UV shielding behavior in order to ascertain optimim loading of Titania. The optimized Ti_nSi hybrid surface was modified with 3-glycidoxy propyl triethoxy silane to obtain Functionalized Titania Silicon hybrid (FTiSi).Coating of FTiSi in

different concentration over the cotton fabric was also achieved using pad-dry-cure approach. The obtained FTiSi nano particles coated cotton fabrics were analyzed for their UV shielding, thermal and basic fabric properties in addition to its laundering durability. The UPF value of 28.2 afforded by the 5 wt % FTiSi coated fabric shows very good UV shielding tendency. Thus, the Titania silicon nanohybrid affords functional behavior to cotton fabric with enhanced UV shielding in addition to their enhanced thermal stability.

Further, with respect to the objective of currentresearch, the UV shielding property of cotton fabric was promoted using silica aerogel doped with minimum amount of Titania. Herein, the Titania Silica Aerogel ($Ti_{1-15}SA$) was prepared from rice husk via sol-gel approach and the optimized sample (Ti_nSA) has been surface modified using 3-glycidoxy propyl triethoxy silane. Further, the obtained Functionalized Titania Silica Aerogel (FTiSA) was coated over cotton fabric using pad-dry-cure method. The obtained cotton fabrics were studied for their UV shielding property, thermal and basic fabric properties in addition to micrograph analysis. It is found that 5 wt % FTiSA coated cotton fabric delivers UPF value of 16.6. These results show that FTiSA coated cotton fabric possesses good UV shielding when compared to neat cotton fabric.

Finally, mesoporous silica SBA-15 was prepared from bio-mass waste rice husk and its UV protective behavior was promoted by doping ceria. It is found that, 5 wt. % Ceria doped SBA-15 (Ce_5S) shows most extraordinary UV protection behavior. To promote the adhesion of Ce_5S with the surface of cotton fabric, the former has been subjected to surface functionalization using 3-glycidoxy propyl triethoxy silane and denoted as FCeS. Further, different weight percent of FCeS were then coated on cotton fabric for optimization using pad-dry cure method. The resulting cotton fabrics were studied for their UV shielding behavior, tensile and thermal

studies. The Ultraviolet Protection Factor (UPF) of the cotton fabric coated with 10 wt. % FCeS reached the maximum of 18.9 in addition to the enhanced tensile strength and thermal stability. This result shows that the ceria doped SBA-15 coated cotton fabric possess good UV shielding property when compared to that of neat cotton fabric. Thus, the developed low cost bio-mass material can find better application as UV shielding material in wide range.

In all the above five approaches, the microstructures of the nano materials derived from rice husk and their hybrids were studied using SEM and TEM analysis. Further, the elemental composition of the derivates and their hybrids were also confirmed through EDAX. Micrograph and elemental analysis of both pristine cotton and nano hybrids coated cotton fabricswere also analysized using SEM and EDAX analysis. In addition, the particle size of the developed nano particles wasalso ascertained using particle size analyser.

In the present work, activated carbon and silica derivatives obtained from biomass rice husk have been used as core and basic coating material to promote the UV shielding and other properties of cotton fabric. To achieve the same, appropriate engineering approaches like doping, functionalization and grafting were successfully carried out and are also confirmed with various physico-chemical analyses. Data obtained from various characterization techniques indicate that the enhanced UV shielding and thermal properties of cotton fabrics are due to the coating of nano materials of rice husk derivatives. Hence the obtained nano materials from rice husks can be used for UV shielding coating, on cotton fabrics with enhanced strength and thermal property for advanced textile applications.