Silica-Xerogel Coated Cotton as Multifunctional Textile: Development and Characterization

SILICA-XEROGEL COATED COTTON AS MULTIFUNCTIONAL TEXTILE: DEVELOPMENT AND CHARACTERIZATION

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ABSTRACT:

Silica xerogel has attracted increasingly more attention in the field of thermal insulation as its extraordinary properties such as thermal conductivity, fire resistance, hydrophobicity and low density. This work focuses on the development of new insulating material, based on the xerogel as charge for cotton fabric. The composite was developed using vacuum molding process. The microstructure has been determined in each materials using SEM observations, and have a good hydrophobicity which the contact angle is 125°. The results obtained from this study can be useful to develop new low cost, sustainable, light product, insulation and environmentally friendly materials**.**

Keywords: Cotton fabric, Hydrophobicity, Physical properties, Porosity, Silica xerogel.

1. INTRODUCTION:

A deal of research [1-5] has been devoted to innovative materials with excellent thermal insulation and fire resistance. Xerogels are considered among the most promising high-performance products for various applications due to their low densities [6], hydrophobicity [7], low thermal conductivity [4]. However, their low mechanical properties have limited their use [5].
Xerogels are defined as a microporous backbone, assimilated to a two phase system (solid and gas) [8]. Prakash C. Thapliyal [9] reported that these materials are gels in which the liquid has been replaced by air, with very moderate shrinkage of a network solid. The combination of structural characteristics gives Xerogels special properties such as filtration and thermal insulation [10]. Deniz Bozoglu and al[11] reported that PU composite film with 7% aerogel had the highest contact angle (105°).

2. MATERIALS AND METHODS:

2.1. Materials:

Cotton fabric, Tetraethyl orthosilicate (TEOS) (98%, M=208,33 g/mol), ethanol (99.8%, M=46,07 g/mol), ammonium hydroxide NH4OH (95%, M=35,04 g/mol) and Hydrochloric acid (0.01M, M=36,458 g/mol). All chemicals were purchased from Sigma-Aldrich, they are analytically pure and used without any further purification.

2.2. Methods:

The preparation method used is sol-gel [12] detailed on next figure (figure1):

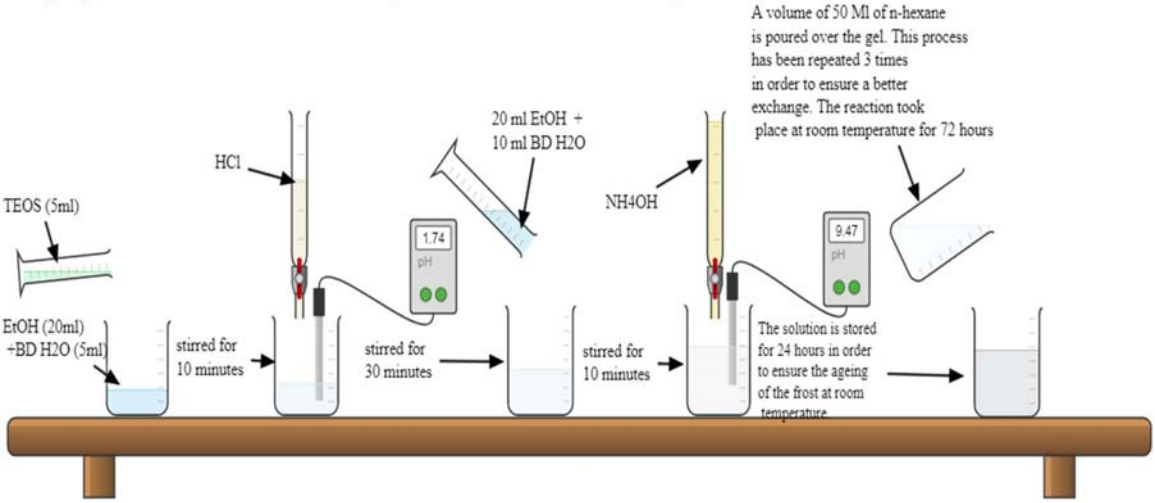

Figure 1: preparation method of silica-xerogel

Finally the gels were dried at a temperature of 60°C for 48 hours. The samples were developed using a coating process, which uses 10% of silica xerogel and 90% of poly acrylate.

3. RESULTS AND DISCUSSION:

3.1. Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray Analysis (EDX) :

Figure 2 show SEM images of silica xerogel obtained with secondary electron detection at accelerating voltages of 15 KV. Almost all the silica xerogel particles were spherical, and their size was about 10 nm. The pore structure of the xerogel, figure 3 show EDX-SEM results of prepared sample; confirm that the sample obtained contains of silice (Si) and oxygen (O) with an atomic percentage respectively of 23.79% and 76.21%.

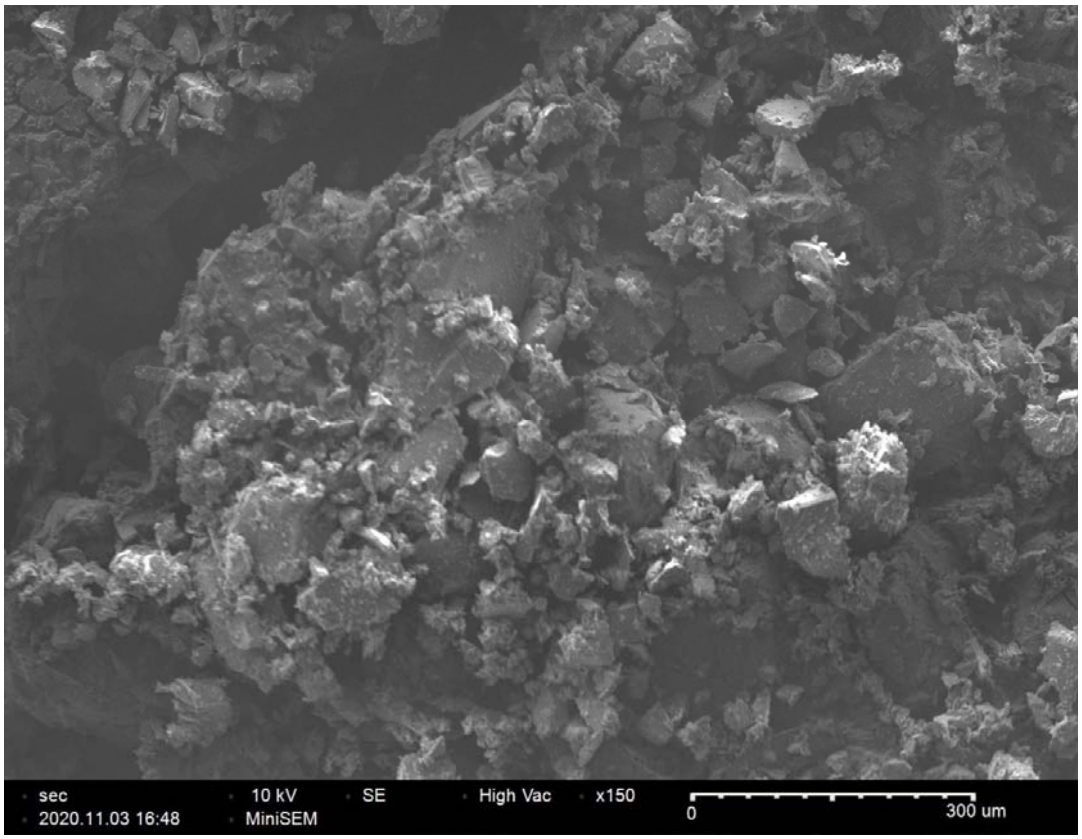

Figure 2: SEM images of xerogel

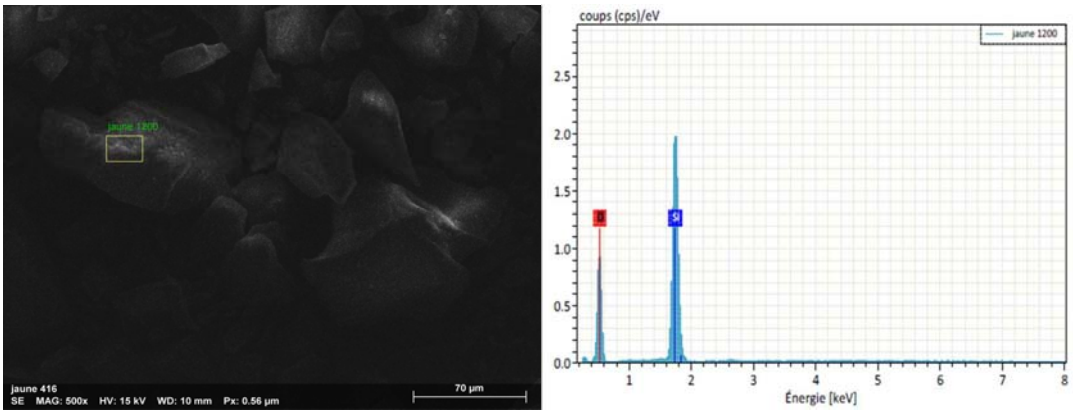

Figure 3: SEM EDX of silica xerogel

3.2. FT-IR Results:

FT-IR spectroscopy was used to study the functional groups present on the surface of hydrophobic silica xerogel. The functional groups present on the surface of the hydrophobic silica xerogel were

studied. Figure 4 shows the FT-IR spectra of each synthesized silica xerogel. The absorption due to the C-H bond was observed at 1360 cm-1 , while the absorption due to the Si-C bond was observed at 1250 cm-1 and 839-757 cm-1. Similarly, the absorption corresponding to the Si-O bond was confirmed at 950 cm-1. On the other hand, the absorption features corresponding to the O-H bond at 3660 cm-1.

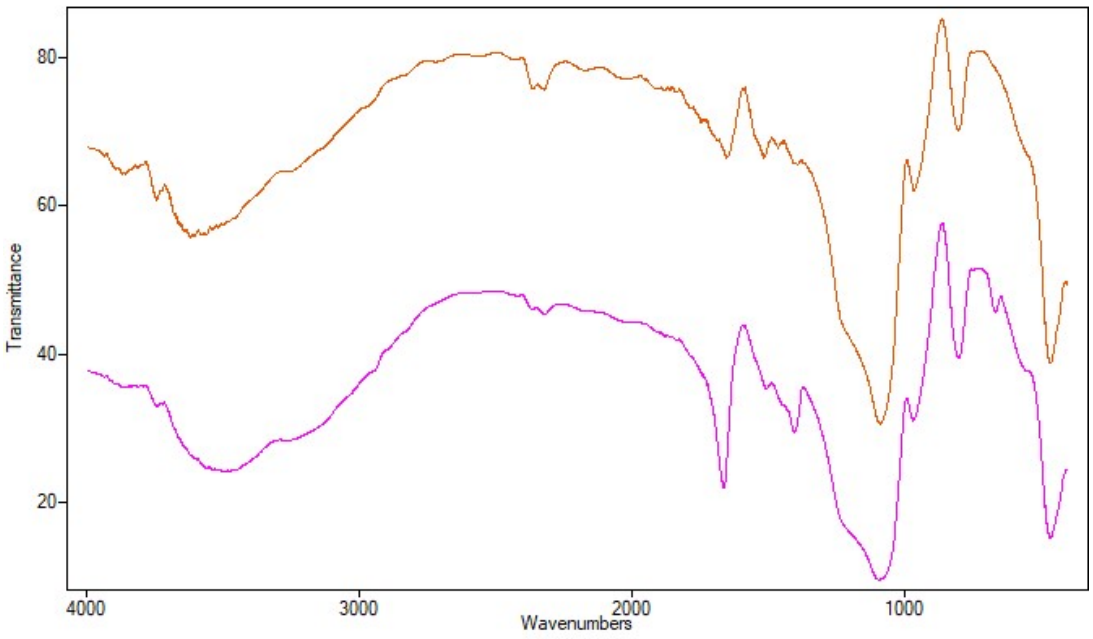

Figure 4: infrared results of silica xerogels

3.3. Contact angle results:

Figure 5 shows that after coating there is a great improvement in the contact angle with a shift from 45.5º for the cotton to 125.1º for treated cotton, with a difference superior to 75º. This shows the transition of the textile state from hydrophilic to hydrophobic.

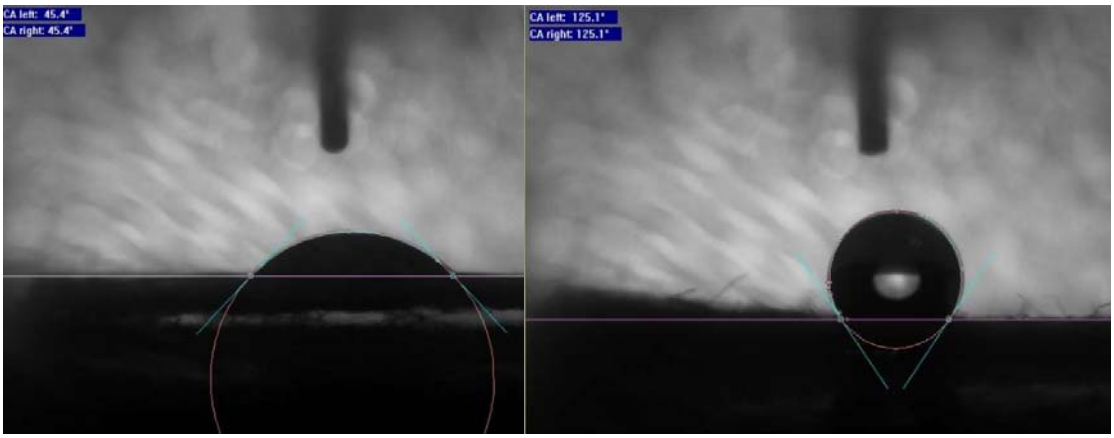

Figure 5: contact angle of composites

3.4: thermal conductivity measurement:

According to the thermal conductivity results there is a big difference between cotton and coated cotton due to the presence of xerogels, he value of thermal conductivity decreases from 0.398 for cotton to 0.136 for coated cotton, that make coated cotton more resistant thermally.

Table 1: value of thermal conductivity

References	cotton	Coated cotton
Thermal conductivity ($W.m^{-1}.k^{-1}$)	0.398	0.136
Thermal resistance ($m^2.k.w^{-1}$)	3.1	9.2

4. CONCLUSION:

Initial results show good adhesion between the sample components, which has been confirmed by the SEM plates. The exchange as well as the modification has been proven by FTIR spectroscopy, resulting in the hydrophobic behavior.

The results obtained from this study can be useful to develop new low cost, sustainable, light product, insulation and environmentally friendly materials.

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