QUALITATIVE RESEARCH JOURNAL FOR SOCIAL STUDIES

ISSN Online: 3006-4686, ISSN Print: 3006-4678
Volume No: 03 Issue No: 02 (2026)

IN HAND NOVEL APPROACHES FOR ENHANCED SOUND ABSORPTION PROPERTIES OF TEXTILE FIBERS. A REVIEW

Author: Khadija Bahadur
Khadijatalha151@gmail.com
MS Scholar, Faculty of Art & Design, Superior University Lahore, Pakistan

Abstract

Owing the unique properties of absorption of sound, individual as well as composites of fiberglass- foam and minerals- fibers are used from a long time. However, there are some health hazards due to the conventional materials. To avoid these issue textile fiber materials can be a good alternative to be the traditional materials. Although the fiber materials made up textile are comparatively low absorber of sound but still they are a potential candidate as they are not harmful human being as well as to environment. To their eco-friendly nature these textile materials can be modified physically or chemically to enhance the sound proof properties. For the physical modification one can choose Nano-fibers, hollow fibers, bio component fibers, micro fibers and aerogel treated fibers which in-hand chemically treated fibers can be obtained via plasma and alkali treatment. The main theme to modify these structures is to dissipate the sound Energy. To achieve the sound, proof quality enhances surface area, increased roughness and tortuosity plays a vital role, the article reviews critically the methods of modifications used by many researchers, to enhance the sound absorption characteristics of textile fibers along with the efficiency of these techniques. The sound absorption coefficient of naturally present fibers can be increased up to 0.9 in mid and high frequencies by using alkali treatment method, whereas the value of this coefficient become pretty higher from micro, hollow and bio component fibers than the natural fibers.

Keywords: Nano-fibers, hollow fibers, sound absorption, bio component fibers, plasma treatment, aerogel treatment

Introduction:

During past few decades, noise pollution has gained much attention of scientific community. To cope with this issue countless efforts have been done and numerous noise absorbing materials are being developed by researcher. Mostly materials in this field are having properties such as. To eliminate the echoes, reduced sound levels(ref) and mainly two types of materials are used in this regard. One is porous absorbers while the other one is panel absorbers. Fibers granules or cellular materials having pores in them can be a potential candidate for acoustic applications (jayamani) owing to peculiar properties, like low cost, outstanding noise absorbent behavior and low specific gravity, textile materials appeared to be promising fibrous absorber. Eco-friendly fibers such as cellulose and protein fibers are conventionally used because they are not hazardous to life as compared to mineral. Fibers, foam and fiberglass (patnaill 2016) now a day's wool passed building materials are frequently used due to decreased consumption of energy and environmental impact (borlea 2020) wool obtained from sheep has enhanced sound absorption capacity over conventionally used mineral fibers over 0.7(Del rejetal 2017). Along with this a wide variety of agriculture by-products, for example Kapor, Kenaf and coir fibers are potentials used for sound absorption (Tanetal 2016).

Although the sound absorption of a variety of sustainable materials, which are fibrous in nature such as recycled polyester and Kenaf are a little lower but even than are comparable with conventionally uses fibers like glass wool and rock wool (Alessandro 2005). The raw foam of natural fibers shows reduced performance in sound absorption. There is a need to develop novel methods and protocols so that to achieve modified fibers with enhanced sound absorption properties (Ravandi 2015). One can modify the textile fibers for enhanced sound absorption characteristics, by chemical treatment if end product or by varying the basic developing

methods of fibers. As compared to the introduction of new fibers in this regard, modification of existing fibers requires less time and low cost
(Perepelkin 2005). Mainly yarns or fabric fibers under consideration for modification.
Figure 1 demonstrates them hand treatment methods of modify the fibers physically and chemically to achieve the enhanced sound absorption capacity.

Sound absorption property characterization of physically (structurally) modified fibers

Fibers can be physically modified by changing their exterior surface or cross-sectional shape without changing their chemical structure, or by changing the supramolecular structure by techniques including spinning, drawing, and relaxing treatment (Perepelkin, 2005). In the low frequency range, fiber diameter significantly improves sound absorption performance (Dunne et al., 2017). Reducing fiber diameter through meticulous selection and execution of the polymerization process, polymer spinning, and drawing conditions is one of the most used physical modification techniques (Ravandi & Valizadeh, 2011). Nick et al. (Nick et al., 2002) found that the sound absorption coefficients of polyester and locally fiber felts were negatively correlated with the fiber diameter. In contrast, a greater number of finer fibers were needed to achieve a given density, resulting in more convoluted passageways and a high impedance to air flow. Furthermore, as pressure changes, finer fibers move more easily than thicker ones. As an alternative, different performances are shown by solid, hollow, or multicomponent cross sectional fibers (Naeimiradet al., 2018). For sound-absorbing applications, bio component fibers made by extruding two molten polymers from the same spinneret outlet have been studied (Celikel & Babaarslan, 2017). In order to create continuous filaments of a semi-solid polymer, a thick, viscous fluid is forced through the perforations of a device known as a spinneret in the extrusion process, which creates hollow threads (Yan et al., 2019). Hollow fibers have a significant capacity to absorb sound because of the axial channel that runs through them (Mahmoud et al., 2012). One particular type of physical fiber modification technique is aerogels that are mechanically reinforced with textile fibers. Aerogel treatment of fibers increases their specific surface area and porosity, showing great promise for sound absorption (Jaxel et al., 2017).

Microfiber's:

A human hair is 100 times finer than a microfiber. A microfiber is a staple fiber or a filament with a linear density of one detox or less. According to Ravani and Valizadeh (2011), microfibers can be produced by dissolving the matrix component of a bio component fiber or by spinning at extremely high speeds. According to Ravani and Valizadeh (2011), microfiber fabrics offer a glossy appearance, a pleasing softness and handle, good drape ability, bulkiness, thermal insulation, and super-absorbent qualities that allow them to absorb more than seven times the water in their weight. Because of their large surface area and enhanced flow resistance, microfiber fabrics absorb sound better than ordinary fiber fabrics at all frequencies. The density and structure of the microfiber fabric determine how much sound is absorbed (Na et al., 2007). Kucuk and Korkmaz (2015) examined the sound absorption characteristics of several bi-layered nonwoven structures with a range of base layers and a top layer made of polyester and polyester/polyamide blends. With a maximum sound absorption coefficient of 0.98, the microfiber layer of polyester fibers supported by 70% wool/30% bio component polyester fibers showed enhanced sound absorption qualities at all frequencies. According to Alcaraz et al. (2017), who investigated the sound absorption characteristics of nonwoven textiles with a woven microfiber resistive layer as the top layer, the sound absorption coefficient significantly increased to 0.9 in the frequency range of 2300–4000 Hz.

2.2 Nanofibers

The processes of bicomponent extrusion, phase separation, template synthesis, drawing, melt blowing, electrospinning, and centrifugal spinning are used to create nanofibers, which are fibers with diameters ranging from 50 to 300 nm. Because it is easy to operate and can create nonwoven mats with a high volume to area ratio, the electrospinning method is frequently employed (Almetwally et al., 2017). A conical shape is created during electrospinning when the hemispherical fluid surface at the spinneret tip is stretched by an increase in the applied electric field (Figure 2). A charged jet of solution is expelled from the tip of the Taylor cone and rapidly speeds to the grounded collecting target when the electrostatic forces caused by the supplied high voltage surpass the surface tension. As seen in Figure 2(b), the jet is normally straight close to the spinneret tip before quickly changing into a whipping motion as a result of electrically driven bending instabilities (Yan et al., 2019). Because of their high surface to volume ratio and extremely small pores, nanofibers have far better acoustical qualities than traditional materials in the low and medium frequency ranges. Sound energy is transformed into heat energy by the frictional contact between the sound wave and the pore walls, which is increased by the high surface area of nanofibers (Bihola & Amin, 2015). The sound absorption behavior of poly acrylonitrile (PAN) nanofabricated composites made with a new technique was examined by Kucukali-Ozturk et al. (2017). The composite was created by electrospinning Nano fibrous membranes based on poly acrylonitrile (PAN) over spacer fabrics. Using 17 and 10 g/m2 nanofiber membranes, the effects of the number of coated layers and the amount of PAN fiber deposition were experimentally examined. Using 17 and 10 g/m2 nanofiber membranes, the effects of the number of coated layers and the amount of PAN fiber deposition were experimentally examined. By applying a layer of nanofibers on one of the following conventional soundproof materials—glass wool, rock wool, foam, kenaf, and polyester Trematerra et al. (2014) investigated the acoustic qualities of nanofibers. The layer of nanofibers is a polymer in formic acid with a 1 lm thickness and an 18% nylon content. The application of the nanofiber coating, which functions as a membrane that vibrates at low and medium frequencies because of its Nano dimensions, enhanced the sound absorption coefficient at low and medium frequencies. The micro membrane oscillates as sound waves strike it, reaching its maximum amplitude at resonance. Na et al. (2012) investigated the impact of the quantity of nanofiber layers on conventional fiber textiles and contrasted the sound absorption coefficients of nanofiber and microfiber fabrics to absorb sound. Using an electrostatic method, polyamide nanofibers (diameter 800 nm) produced by melt spinning were transformed into nanofiber textiles. To achieve the same area density (mass per unit area of the fabric) as reference samples of microfiber textiles, those nanofiber fabric layers were plied together. Six layers of nanofibers were applied to a conventional fiber fabric in order to examine the sound-absorbing properties of the nanofiber layers. Because sound waves interact with the large specific surface of nanofibers, the nanofiber textiles were better at absorbing sound within the audible frequency range than the microfiber fabrics. This study demonstrated that the vibrations of the Nano layers and air friction within the Nano pores enhance the efficiency of sound-absorbing materials. The possible use of discarded natural fibers from spinning mills as a remedy for the expanding trend towards sustainable acoustic applications was demonstrated by Krucinska et al. (2015). Conventional cotton fibers were utilized as reinforcement for the conventional polylactic acid (PLA) fiber matrix, whereas the ultra-short/ultra-fine flax fibers, which had a length of 6.14 lm and a fineness of around 0.05 denier, were utilized alone. The PLA/CO (50/50) nonwoven matrix's sound absorption coefficient rose to 0.7–0.8 for the 2000–6400 Hz frequency range when both ultra-short and ultra-fine flax fibers were included. Ulrich and Arenas (2020) discovered recently that using a Nano fibrous membrane as a coating may greatly increase the sound absorption coefficients of porous bulk materials (polyester textile, melamine foam).

Hollow Fibers

An axial channel found in hollow fibers allow air to pass through while also absorbing sound. The axial channel's cross sections typically have the following shapes: square, triangular, trilobal, and circular. These fibers have superior cover, are lightweight, highly breathable, and have strong heat-insulating qualities (Ravandi & Valizadeh, 2011). One such naturally occurring hollow fiber is estabragh fiber, which has a round cross-section and a 3.38 denier fiber fineness.

Estabragh fibers have a higher sound absorption capacity because of their hollow fiber structure, despite the fact that polypropylene fibers are finer (Taylor et al., 2014). However, due to crimp and a lack of cohesiveness, 55.5% of the estabragh fibers sustain damage during the carding process (Gharehaghaji & Davoodi, 2008). Blending estabragh fibers with other fiber types is a frequent corrective method used to address fiber degradation (Andrews et al., 1989). Taylor et al. (2014) investigated how the blend % of polypropylene/estabragh blended fabrics affected the fabrics' acoustic absorption capabilities and found that the higher the percentage of estabragh fiber, the higher the sound absorption coefficient.

Another natural fiber with an 80–90% hollow structure is kapok fiber, which finds extensive use in acoustic applications because of its hollow nature (Liu et al., 2015; Bhattacharya & Bihola, 2019). Jie et al. (2017) investigated the hydrogenated carboxyl nitrile butadiene rubber composites reinforced with single-hole hollow polyester fiber (SHHPF) and the effects of composite thickness and fiber content on sound absorption characteristics. When the SHHPF content was raised to 40%, the sound absorption coefficient significantly enhanced because of the increased surface area and convoluted pathways. Beyond 40% of SHHPF, however, the sound absorption property decreased because the composite's increasing density inhibits the vibration action between fibers, lowering sound absorption. Devi (2014) examined the sound-absorbing qualities of blended nonwovens made of solid and hollow polyester. Compared to samples made entirely of solid polyester, those with a higher percentage of hollow polyester had a better sound absorption coefficient. The nature of hollow fibers explains why the fraction of hollow fibers and sound absorption efficiency are directly correlated. The nature of hollow fibers explains why the fraction of hollow fibers and sound absorption efficiency are directly correlated. The air volume inside the fabric is increased by the lumen, which also improves the fabric's capacity to absorb sound (Mahmoud et al., 2012).

Bicomponent Fibers

According to Takematsu et al. (2018), bicomponent fiber is a unique kind of fiber that combines two polymers into a single fiber. One of the polymers melted earlier and adhered to nearby fibers during the formation of nonwovens from bicomponent fibers, resulting in a rough fiber surface. Due to increased bonding and reduced air permeability, bio-component fiber layers absorb sound more than homocomponent analogs (Celikel & Babaarslan, 2017). Celikel and Babaarslan (2017) examined how bicomponent fibers affected the capacity of multilayer nonwoven textiles to absorb sound. The polyester fiber nonwovens used in this work have three layers composed of four distinct cross-sectional types of polyester fibers: bicomponent round /.bv(Bi-R), bio-component trilobal (Bi-T), homocomponent round (R), and homo-component trilobal (T). Figure 3 shows these four categories of cross sections. The bicomponent fibers were composed of 10% co-polyester sheath with a melting point of 110–

140C and 90% polyester (PET) core with a melting point of 230–250C. Using multiple di-acids or diols during the polymerization process, co-polyester is another kind of polyester. The test findings show that multilayer nonwovens with bicomponent fibers as the outer layer absorb sound better than nonwoven constructions with homocomponent fibers because of their stronger bonds and reduced permeability. Co-polyester fibers melt earlier and stick to neighboring fibers during the calendaring process, causing frictional losses of sound energy (Celikel & Babaarslan, 2017).

2.5. Imparting crimp to the fibers

The degree to which a non-straight fiber deviates from linearity is known as its crimp or waviness. Cotton and other natural fibers naturally crimp, but synthetic fibers should have artificial waviness added for improved cohesiveness and friction (Maity, 2014). Better sound absorption results from adding the fibers crimp, which increases the volume of air trapped by the fibers and their tortuous routes. Numerous methods, such as stuffer box crimped, gear crimped, helical crimped, and combinations of these, are used to create crimped fibers (Thompson et al., 2018). A number of metrics, including wavelength, crimp length, crimp frequency, crimp angle, crimp index, crimp amplitude, and crimp degree, are used to measure crimp. The number of crimp bows or waves per unit length of straightened fiber is known as the crimp frequency (Maity, 2014). The impact of crimp frequency on the sound absorption coefficient of batts (large fiber sheets layered using a laboratory carding machine) made of staple polypropylene fibers with crimp frequencies of 1.9, 2.3, and 3.6 crimp per cm was investigated by Panahi et al. (2015), who discovered that higher crimp frequency leads to higher sound absorption. At a crimp frequency of 3.6, the maximum sound absorption coefficient recorded was 0.78. Shorter straight fiber lengths and more creases along the fibers reduced the accessible surface for sound reflection when the crimp frequency of the samples was raised while maintaining a constant weight. Higher tortuosity, which provides a greater resistance against sound waves, was the result of increasing fiber crimp. The primary cause of the rise in sound absorption is the higher resistance brought on by winding routes.

2.6. Treating fibers with aerogels

Aerogel is a very low density solid that is produced by super-critically drying a gel to remove its liquid component (Sagar & Babasaheb, 2018). High specific surface area, extremely high porosity, low bulk density, exceptional textural qualities, and inflammability are all common characteristics of aerogels. Because of their loosely packed, open porosity networks, aerogels mechanically bonded with textile fibers show great promise for sound-absorbing applications (Garcıa-Gonzalez et al., 2019). The ability of single and layered layers of polyester/polyethylene nonwovens embedded with hydrophobic amorphous silica aerogel to absorb sound was examined by Yang et al. (Yang et al., 2019). Single layer aerogel/polymer nonwovens sound absorption coefficients range from 0.0556 to 0.0858 suggesting that they are ineffective sound absorbers. At 4136 Hz, however, the two-layer laminated aerogel/polymer nonwoven sample's sound absorption coefficient peaked at 0.9978. Oh et al. (2009) looked at the PET/Aerogel blanket's ability to absorb sound and provide thermal insulation utilizing two different manufacturing processes. By dipping and swelling PET nonwoven fabric in an Ortho Silicate (TEOS)/ethanol mixture and using HCl to get the pH of the reaction fluid down to 2.5 in order to encourage hydrolysis, the first technique involved the direct gelation of silica on PET. Following acid hydrolysis, NH4OH was used to raise the pH to over 7 for condensation. The second procedure was the dipping of PET nonwoven fabric in the dispersion of Silica hydrogel. The PET/Aerogel blanket's sound absorption coefficient, which was produced by directly gelating a significant amount of silica onto PET, grew gradually and peaked at 0.4 at frequencies higher than 1000 Hz. Aerogels may prove to be a viable substitute for traditional sound absorbers if their mechanical qualities are enhanced and their manufacturing costs are decreased (Bheekhun et al., 2013).

3. Sound absorption property characterization of chemically modified fibers

Chemical modifications are made to fiber structures either right before spinning or during the processing of completed fibers by introducing additional functional groups that will react with the fibers (Perepelkin, 2005).

Alkali treatment:

The performance of a material as an acoustic absorber is influenced by several characteristics of the fibers used to create it, including fiber type, chemical composition, morphology, and surface treatment (Nasidi et al., 2018). In particular, sound energy dissipation increases as surface roughness of fibers increases; thus, sound absorption capabilities in most cases will be enhanced as fiber surface roughness increases (Cao et al., 2018). The application of plasma and Na OH treatments on natural fiber composites is common to generally reduce fiber diameter and thus improve the interfacial bond strength between the various fiber components due to increased mechanical interlocking resulting from reduced fiber diameter. The Na OH treatment of fibers results in decreased fiber diameter due to the removal of hemicellulose, lignin and wax-like tolling from the fiber surface, as well as, the generation of pore-like structures on the surface of the treated fiber as a result of partial lignin removal; improving the acoustic properties of the fibers (Oushabi et al., 2017). For example, when bagasse and oil palm treated with Na OH fiber are evaluated as an additive to natural rubber foams (maximum sound absorption coefficient equals approximately 0.4), at mid- to high-frequency ranges, the sound absorption coefficient increases to approximately 0.9 (Tomyangkul et al., 2016).

Sari et al. (2016) looked at the acoustic characteristics of untreated and alkali-treated maize husk fibers. The fibers were treated with a sodium hydroxide solution of different concentrations (i.e., 1%, 2%, 5%, and 8%) for two hours at the standard conditions of temperature and humidity. The authors have reported on the sound absorption properties of untreated as well as alkali treated corn husk fibers that have been chemically modified by the addition of sodium hydroxide (1%, 2%, 5% and 8%). The corn husk fibers were soaked in sodium hydroxide for a period of two hours at room temperature and under normal relative humidity conditions. The untreated corn husk fiber sample reached a maximum sound absorption coefficient of 0.93. With regard to their acoustic properties, the alkali treated corn husk fiber samples demonstrated a significant improvement in performance (with sound absorption coefficients ranging from 0.98 to 0.99) over the frequency range of 1.6 to 3.25 kHz, suggesting that chemical treatment significantly improves the ability of the fiber to dissipate sound energy from impact, particularly in the medium to high frequency range. The reduction in the diameter of the fiber due to chemical treatment results from the removal of amorphous materials (such as lignin and hemicellulose) from the fiber structure. In addition to cleaning the surface of the fiber, the removal of these materials will increase the surface roughness of the fiber and may also result in the formation of additional micro-pores. Consequently, the density of the fibers has increased because of the increased volume of the fibers (volume density). The higher volume density will lead to an increase in resistivity to airflow through the fibers. The higher airflow resistivity will lead to more frictional interactions between sound waves and the fibers, resulting in greater energy lost via thermal and viscous means. Overall porosity has decreased as a result of the increased number of fibers occupying the structure, helping to improve the sound attenuation performance of the material.

Plasma Treatment:

Plasma is a mixture of electrically charged gases, including electrons, ions, atoms, and molecules along with other products created from the breakdown of these electrified gases. Since the electrical charges in plasma can chemically interact with the fiber surface to create both physical and chemically changed surfaces, this generally does not alter the integrity of the main body of the fiber. Plasma surface treatment alters both the chemistry and energy of the surface of the fibers through a variety of surface reactions such as etching, activation, and modification of the fibers. These chemical and physical changes created on the surface of the fibers lead to a roughened texture or texture of the fiber surface, yielding more surface area from which sound waves will bounce off and eventually impact the structure of loosely bound fibers resulting in changing how sound is transmitted through these loosely bound fibers. As the surface texture and surface area of the fibers become rougher and more pronounced, the fiber-to-air interaction increases and causes physical changes to the internal structure of the fiber matrix thus changing the way sound travels through these loosely bound matrices. The increase in surface roughness and surface area of the fibers creates more frictional resistance between the fibers and the sound waves, yielding more loss of sound through dissipation of sound energy into the loosely bound fiber matrix (Sun, 2018).

According to Na and Cho (2010), the sound absorption characteristics of polyester fibers have shown substantial improvement following exposure to plasma treatment. The increase in sound absorption coefficient for standard solid polyester fibers is moderate at about 0–4.6%, while hollow polyester fibers have approximately 11.6–12.5% greater sound absorption coefficient after being exposed to plasma. The improved acoustical performance of these hollow polyester fibers is due, in large part, to the presence of an internal void or cavity which provides for additional paths through which sound energy can be dissipated or internally reflected as well as to the surface property changes caused by the plasma treatment which increase the potential for sound to be absorbed; The surface roughness of the fibers is increased through micro-etching and surface activation effects as a result of being plasma treated. Changes in surface morphology (i.e. increased roughness) are more substantial in the case of hollow polyester fibers than they are for solid polyester fibers, because hollow polyester fibers have a much larger specific surface area, allowing more surface area to be exposed to the reactive plasma. The greater surface roughness (increased surface irregularities) associated with hollow polyester fibers will increase the fiber–air interaction; therefore, they will have increased resistance to impacting sound waves through friction, which will enhance the dissipation of acoustic energy.

Nevertheless, an excessive plasma exposure causes material degradation leading to loss of strength and acoustic efficiency due to excessive plasma treatment times of fibers like jute. For example, beyond three (3) seconds of treatment time with plasma the absorption coefficient for jute fibers decreased, which is due to damage to fiber surfaces as well as erosion of materials and weight loss from long exposure to high energy plasma particles. Additionally, the removal of lignin is beneficial when done in moderation; however, an excessive amount of lignin removal will decrease the cohesive bond between fibers. The lignin is an ingredient that allows for natural binding between the fibrillary component of a fiber; therefore, too much lignin can create poorly bonded fibrillary components, surface fracturing or instability in the fiber itself which will negatively impact the structure of the fiber matrix as a whole and, ultimately, diminish its capability to absorb and disperse sound energy. Fibers have been defined as containing carbohydrate-rich content and, therefore, are often very susceptible to surface degradation when exposed to plasma. The outer layers consist primarily of cellulose and hemicellulose; therefore, the erosion of these components can expose the underlying lignin to further degradation reactions. As a result, if not properly controlled, the progressive modification of the surface structure of the fibers can cause a change in the physical and acoustic performance of the fiber.

Kenaf fiber has more mechanical strength than that of jute. When kenaf fibers were plasma treated for a period of six seconds, the sound absorption coefficient increased by about 4.6 to 9.4% (Na & Cho 2010), which suggests that if plasma exposure is carefully controlled, it will improve acoustic efficiency without destroying the overall structure. Pavlovich et al. (2019) studied natural cellulose-based fibrous materials using low-pressure radio-frequency argon to determine their acoustical behavior after treatments with plasma. The authors reported that the sound absorption coefficients for both randomly oriented and directionally oriented fibrous structures increased with plasma modifications. Hence, it appears that proper optimization of the treatment conditions will lead to an improvement in acoustic properties of the details regardless of fiber orientation.

Discussion

A variety of interdependent fiber, yarn, and fabric qualities produces the ability of textile materials to absorb sound (Sun, 2018). The methods of altering fiber characteristics to improve textile fiber sound absorption and the efficacy of these alterations were the main topics of this review article.

The acoustic industry has concentrated on textile fibers for sound-absorbing solutions because of the health hazards connected to traditional fibers. However, compared to mineral fibers, which have an average sound absorption coefficient near 1, textile fibers in their natural state exhibit relatively poor sound absorption qualities. It is possible to alter the textile fibers chemically or physically to make them more efficient sound absorbers (Ravandi et al., 2015). It is well established that altering the chemical structure and morphology of the constituent fibers through physical and chemical modifications, such as microfibers, nanofibers, hollow fibers, bio-component fibers, crimped fibers, plasma treatment, and alkali treatment, can raise the average sound absorption coefficient of textile fibers/fiber structures by up to 0.8–0.9.

The most important factors influencing the fiber modification technique are the fiber type and the final product's performance requirements. In the spinning step, synthetic fibers can be altered to become hollow, bio-component, micro, Nano, and crimped fibers, resulting in an optimal sound-absorbing coefficient of 0.78 to 0.98. Table 1 lists the inherited traits of every physical modification technique. With the help of earlier studies covered in the review, the fiber modification technique for synthetic fibers should be chosen based on the fiber type and final product performance requirements.

Natural fiber materials are far safer to use for sound attenuation than synthetic ones (Yahya & Chin, 2017). However, for absorbers based on cotton, flax, ramie, sisal, jute, and wool fibers, the average NAC values at 500 Hz were 0.50, 0.40, 0.10, 0.20, and 0.20, respectively (Patnaik, 2016). By eliminating hemicellulose and lignin, the alkali treatment can increase the sound absorption coefficient of natural fibers by 0.9 to 0.99 contaminants on the fiber surface that are waxy. Additionally, the surface of the fiber develops pores as lignin dissolves (Oushabi et al., 2017).

By regulating the treatment duration based on the kind of fiber, plasma therapy can raise the sound absorption coefficient of both synthetic and natural fibers. Regular polyester fibers, hollow polyester fibers, and kenaf fibers can all have their sound absorption coefficients increased by 0–4.6%, 11.6–12.5%, and 4.6–9.4%, respectively, by applying plasma treatment (Na & Cho, 2010). Because plasma treatment uses few chemicals and takes little time to complete, it is an environmentally benign method of surface modification. Additionally, plasma treatment positively impacts the mechanical characteristics of fibers, including maximum tensile strength and elongation at break (Sun, 2018).

Conclusion:

The ability of textile fibers to absorb sound is greatly improved by chemical and physical modification techniques such as microfibers, nanofibers, hollow fibers, bio-component fibers, crimped fibers, plasma treatment, and alkali treatment. The sound absorption coefficients of conventional materials used in sound absorption are equivalent to those of modified fiber architectures. The type of fiber and the final product's performance criteria should be taken into consideration while choosing the modification technique. By chemically or physically altering fibers, textile fibrous materials with improved sound absorptivity can take the role of conventional hazardous sound-absorbing materials.

Refrences:

Alcaraz, M. P. S., Bonet-Aracil, M., Alcaraz, J. G. S., & Seguí, I. M. (2017). Sound absorption of textile material using a microfibres resistive layer. *IOP Conference Series: Materials Science and Engineering*, *254*, 072022. https://doi.org/10.1088/1757-899X/254/7/072022

Alessandro, F. D., & Pispola, G. (2005). Sound absorption properties of sustainable fibrous materials in an enhanced reverberation room. *Proceedings of the 2005 Congress and Exposition on Noise Control Engineering*, 1–10.

Almetwally, A. A., El-Sakhawy, M., Elshakankery, M. H., & Kasem, M. H. (2017). Technology of nano-fibres: Production techniques and properties – A critical review. *Journal of Textile Association*, *78*(1), 5–14.

Andrews, B. A. K., Kimmel, L. B., Bertoniere, N. R., & Hebert, J. J. (1989). Comparison of the response of cotton and milkweed to selected swelling and crosslinking treatments. *Textile Research Journal*, *59*(11), 309–313.

Berardi, U., Iannace, G., & Gabriele, M. D. (2016). *Characterization of sheep wool panels for room acoustic applications* [Paper presentation]. 22nd International Congress on Acoustics for the 21st Century. https://doi.org/10.1121/2.0000336

Bhattacharya, S. S., & Bihola, D. V. (2019). Acoustic properties of kapok fibre. *International Journal of Engineering and Advanced Technology*, *9*(1), 2164–2168. https://doi.org/10.35940/ijeat.A9688.109119

Bheekhun, N., Rahim, A., Talib, A., & Hassan, M. R. (2013). Aerogels in aerospace: An overview. *Advances in Materials Science and Engineering*, *2013*, 1–18. https://doi.org/10.1155/2013/406065

Bihola, D., & Amin, H. N. (2015). Application of nano material to enhance acoustic properties. *Engineering Science and Futuristic Technology*, *1*(12), 1–9.

Borlea (Muresan), S. I., Tiuc, A.-E., Nemes, O., Vermesan, H., & Vasile, O. (2020). Innovative use of sheep wool for obtaining materials with improved sound-absorbing properties. *Materials*, *13*(3), 694. https://doi.org/10.3390/ma13030694

Cao, L., Fu, Q., Si, Y., Ding, B., & Yu, J. (2018). Porous materials for sound absorption. *Composites Communications*, *10*, 25–35. https://doi.org/10.1016/j.coco.2018.05.001

Celikel, D. C., & Babaarslan, O. (2017). Effect of bicomponent fibres on sound absorption properties of multilayer nonwovens. *Journal of Engineered Fibres and Fabrics*, *12*(4), 15–25.

Dasdemir, M., Maze, B., Anantharamaiah, N., & Pourdeyhimi, B. (2012). Influence of polymer type, composition, and interface on the structural and mechanical properties of core/sheath type bicomponent nonwoven fibres. *Journal of Materials Science*, *47*(16), 5955–5969. https://doi.org/10.1007/s10853-012-6499-7

Del Rey, R., Uris, A., Alba, J., & Candelas, P. (2017). Characterization of sheep wool as a sustainable material for acoustic applications. *Materials*, *10*(11), 1277. https://doi.org/10.3390/ma10111277

Devi, R. P. (2014). A study on acoustic properties of polyester and hollow polyester non woven fabrics. *International Journal of Advanced Technology in Engineering and Science*, *2*(1), 446–459.

Dunne, R., Desai, D., & Sadiku, R. (2017). A review of the factors that influence sound absorption and the available empirical models for fibrous materials. *Acoustics Australia*, *45*(2), 453–469. https://doi.org/10.1007/s40857-017-0097-4

García-González, C. A., Budtova, T., Durães, L., Erkey, C., Gaudio, P. D., Gurikov, P., Koebel, M., Liebner, F., Neagu, M., & Smirnova, I. (2019). An opinion paper on aerogels for biomedical and environmental applications. *Molecules*, *24*(9), 1815.

Gharehaghaji, A. A., & Davoodi, S. H. (2008). Mechanical damage to Estabragh fibres in the production of thermobonded layers. *Journal of Applied Polymer Science*, *109*(5), 3062–3069. https://doi.org/10.1002/app

Jaxel, J., Markevicius, G., Rigacci, A., & Budtova, T. (2017). Thermal superinsulating silica aerogels reinforced with short man-made cellulose fibres. *Composites Part A: Applied Science and Manufacturing*, *103*, 1–28. https://doi.org/10.1016/j.compositesa.2017.09.018

Jayamani, E. (2015). *Sound absorption and impedance study of lignocellulosic fibre based composites for acoustical applications* [Doctoral dissertation, University Malaysia Sarawak].

Jie, H., Sheng, J., & Xiong, Y. (2017). Sound absorption properties of single-hole hollow polyester fibre reinforced hydrogenerated carboxyl nitrile rubber composites. *Autex Research Journal*, *17*(3), 263–267. https://doi.org/10.1515/aut-2016-0014

Krucinska, I., Gliscinska, E., Michalak, M., Ciechanska, D., Kazimierczak, J., & Bloda, A. (2015). Sound-absorbing green composites based on cellulose ultra-short/ultra-fine fibres. *Textile Research Journal*, *85*(6), 646–657. https://doi.org/10.1177/0040517514553873

Kucuk, M., & Korkmaz, Y. (2015). Sound absorption properties of bilayered nonwoven composites. *Fibers and Polymers*, *16*(4), 941–942. https://doi.org/10.1007/s12221-015-0941-9

Kucukali-Ozturk, M., Ozden-Yenigun, E., Nergis, B., & Candan, C. (2017). Nanofibre enhanced light-weight composite textiles for acoustic applications. *Journal of Industrial Textiles*, *46*(7), 1498–1510. https://doi.org/10.1177/1528083715622427

Lim, Z. Y., Putra, A., Nor, M. J. M., & Yaakob, M. Y. (2018). Sound absorption performance of natural kenaf fibres. *Applied Acoustics*, *130*, 107–114. https://doi.org/10.1016/j.apacoust.2017.09.012

Liu, X., Yan, X., & Zhang, H. (2015). Sound absorption model of kapok-based fibre nonwoven fabrics. *Textile Research Journal*, *85*(9), 969–979. https://doi.org/10.1177/0040517514557313

Mahmoud, A., El-Shenawy, G., & Ramadan, E. (2012). Using nonwoven hollow fibres to improve cars interior acoustic properties. *Research Journal of Textile and Apparel*, *16*(3), 49–56. https://doi.org/10.1108/RJTA-16-03-2012-B005

Mahzan, S., Zaidi, A. M. A., Yahya, M. N., & Ismail, M. (2009). Investigation on sound absorption of rice-husk reinforced composite. *Malaysian Technical Universities Conference on Engineering and Technology*, 19–22.

Maity, S. (2014). Characteristics and effects of fibre crimp in nonwoven structure. *Journal of the Textile Association*, 360–366.

Na, Y., Agnhage, T., & Cho, G. (2012). Sound absorption of multiple layers of nanofibre webs and the comparison of measuring methods for sound absorption coefficients. *Fibers and Polymers*, *13*(10), 1348–1352. https://doi.org/10.1007/s12221-012-1348-5

Na, Y., & Cho, G. (2010). Sound absorption and viscoelastic property of acoustical automotive nonwovens and their plasma treatment. *Fibers and Polymers*, *11*(5), 782–789. https://doi.org/10.1007/s12221-010-0782-5

Na, Y. J., Lancaster, J., Casali, J., & Cho, G. (2007). Sound absorption coefficients of micro-fibre fabrics by reverberation room method. *Textile Research Journal*, *77*(5), 330–335. https://doi.org/10.1177/0040517507078743

Naeimirad, M., Zadhoush, A., Kotek, R., Esmaeely Neisiany, R., Nouri Khorasani, S., & Ramakrishna, S. (2018). Recent advances in core/shell bicomponent fibres and nanofibres: A review. *Journal of Applied Polymer Science*, *135*(21), 46265. https://doi.org/10.1002/app.46265

Nasidi, I. N., Ismail, L. H., & Samsudin, E. M. (2018). The effect of natural fibre sound absorption performance on sodium hydroxide treatment. *25th International Congress on Sound and Vibration*, 1–8.

Nick, A., Becker, U., & Thoma, W. (2002). Improved acoustic behavior of interior parts of renewable resources in the automotive industry. *Journal of Polymers and the Environment*, *10*(3), 115–118. https://doi.org/10.1023/A:1021124214818

Oh, K. W., Kim, D. K., & Kim, S. H. (2009). Ultra-porous flexible PET/aerogel blanket for sound absorption and thermal insulation. *Fibers and Polymers*, *10*(5), 731–737. https://doi.org/10.1007/s12221-010-0731-3

Oushabi, A., Sair, S., Hassani, F. O., Abboud, Y., Tanane, O., & Bouari, A. E. (2017). The effect of alkali treatment on mechanical, morphological and thermal properties of date palm fibres (DPFs): Study of the interface of DPF–polyurethane composite. *South African Journal of Chemical Engineering*, *23*, 116–123.

Panahi, M., Tavanai, H., & Zarrebini, M. (2015). The influence of fibre crimp on acoustic performance of polypropylene fibrous batts. *Journal of Textiles and Polymers*, *3*(2), 71–75.

Patnaik, A. (2016). Materials used for acoustic textiles. In R. Nayak & R. Padhye (Eds.), *Acoustic textiles* (pp. 73–92). Springer. https://doi.org/10.1007/978-981-10-1476-5

Pavlovic, S. S., Stankovic, S. B., Zekic, A., Nenadovic, M., Popovic, D. M., Milosavljevic, V., & Poparic, G. B. (2019). Impact of plasma treatment on acoustic properties of natural cellulose materials. *Cellulose*, *26*, 6543–6554. https://doi.org/10.1007/s10570-019-02547-1

Perepelkin, K. E. (2005). Principles and methods of modification of fibres and fibre materials: A review. *Fibre Chemistry*, *37*(2), 123–151. https://doi.org/10.1007/s10692-005-0069-6

Ravandi, M. R. G., Mardi, H., Langari, A. A. A., Mohammadian, M., & Khanjani, N. (2015). A review on the acoustical properties of natural and synthetic noise absorbents. *Open Access Library Journal*, *2*(8), 1–11. https://doi.org/10.4236/oalib.1101598

Ravandi, S. A. H., & Valizadeh, M. (2011). Properties of fibres and fabrics that contribute to human comfort. In G. Song (Ed.), *Improving comfort in clothing* (pp. 61–78). Elsevier. https://doi.org/10.1533/9780857090645.1.61

Sagar, S. G., & Babasaheb, C. L. (2018). A review on aerogel: An introduction. *International Research Journal of Engineering and Technology*, *5*(3), 4098–4101.

Sari, N. H., Wardana, I. N. G., Irawan, Y. S., & Siswanto, E. (2016). Physical and acoustical properties of corn husk fibre panels. *Advances in Acoustics and Vibration*, *2016*, 1–7. https://doi.org/10.1155/2016/5971814

Seddeq, H. S. (2009). Factors influencing acoustic performance of sound absorptive materials. *Australian Journal of Basic and Applied Sciences*, *3*(4), 4610–4617.

Sim, J. S. T., Zulkifli, R., Tahir, M. F. M., & Elwaleed, A. K. (2014). Recycled paper fibres as sound absorbing material. *Applied Mechanics and Materials*, *663*, 459–463. https://doi.org/10.4028/www.scientific.net/AMM.663.459

Sun, D. (2018). Surface modification of natural fibres using plasma treatment. In S. Kalia (Ed.), *Biodegradable green composites* (pp. 1–26). Wiley. https://doi.org/10.1002/9781118911068.ch2

Takematsu, M. M., Diniz, M. F., Mattos, C., Cassia, R. D., & Dutra, L. (2018). Sheath-core bicomponent fibre characterization by FT-IR and other analytical methodologies. *Polímeros*, *28*(4), 339–347. https://doi.org/10.1590/0104-1428.09016

Tan, W., Lim, E. A., Chuah, H. G., Cheng, E. M., & Lam, C. K. (2016). Sound transmission loss of natural fibre panel. *International Journal of Mechanical & Mechatronics Engineering*, *1*(6), 33–42.

Taylor, P., Hassanzadeh, S., Hasani, H., & Zarrebini, M. (2014). Analysis and prediction of the noise reduction coefficient of lightly needled Estabragh/polypropylene nonwovens using simplex lattice design. *The Journal of the Textile Institute*, *105*(3), 241–256. https://doi.org/10.1080/00405000.2013.835903

Thompson, D. R., Gerdes, R. W., & Nelson, B. L. (2018). *Sound insulation constructions and methods of using the same* (U.S. Patent No. US20080001431A1). U.S. Patent and Trademark Office. https://patents.google.com/patent/US20080001431

Tomyangkul, S., Pongmuksuwan, P., Harnnarongchai, W., & Chaochanchaikul, K. (2016). Enhancing sound absorption properties of open-cell natural rubber foams with treated bagasse and oil palm fibres. *Journal of Reinforced Plastics and Composites*, *35*(8), 688–697. https://doi.org/10.1177/0731684415627295

Trematerra, A., Iannace, G., Nesti, S., & Next, E. F. (2014). Acoustic properties of nanofibres. *Forum Acusticum*, 7–12.

Ulrich, T., & Arenas, J. P. (2020). Sound absorption of sustainable polymer nanofibrous thin membranes bonded to a bulk porous material. *Sustainability*, *12*(2361), 1–15.

Yahya, M. N., & Chin, D. D. V. S. (2017). A review on the potential of natural fibre for sound absorption application. *IOP Conference Series: Materials Science and Engineering*, *226*, 012014. https://doi.org/10.1088/1757-899X/226/1/012014

Yan, X., Yu, M., Ramakrishna, S., Russell, S. J., & Long, Y.-Z. (2019). Advances in portable electrospinning devices for in situ delivery of personalized wound care. *Nanoscale*, 1–13. https://doi.org/10.1039/c9nr02802a

Yang, T., Xiong, X., Venkataraman, M., Mishra, R., Novak, J., & Militky, J. (2019). Investigation on sound absorption properties of aerogel/polymer nonwovens. *The Journal of the Textile Institute*, *110*(2), 196–205. https://doi.org/10.1080/00405000.2018.1472540

Zhu, J., Ge, Y., Jasper, S., & Zhang, X. (2017). Physical characterization of electrospun nanofibres. In A. Contractor (Ed.), *Electrospun nanofibres* (pp. 208–236). Elsevier. https://doi.org/10.1016/B978-0-08-100907-9.00009-X

Zunaidi, N. H., Tan, W. H., Hannan, N. I. R. R., & Shahidan, S. (2017). A review: Characteristics of noise absorbing material. *Journal of Physics: Conference Series* [details not fully available in source; verify volume and page numbers before submission].