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Jayawardana Withanage Achini Madushika & Wilathgamuwage Don Gamini Lanarolle

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REVIEW

A review on novel approaches to enhance sound absorbing performance using textile fibers

Jayawardana Withanage Achini Madushika and Wilathgamuwage Don Gamini Lanarolle

University of Moratuwa, Moratuwa, Sri Lanka

ABSTRACT
Fibreglass, foam, mineral fibres and their composites are the conventional materials used in applications that require absorption of sound. However, due to the health risks associated with the traditional materials, textile fibrous structures are becoming a valid alternative in spite of their comparatively lower sound absorption properties. The existing textile structures and textile structures specifically modified physically or chemically to enhance sound absorption properties have been experimented for better performance in sound-related properties. The fibres have been chemically modified using plasma treatments and alkali treatments, while microfibres, nanofibres, hollow fibres, bicomponent fibres, crimp fibres and aerogel-treated fibres are produced to modify the physical structures of fibres. The basic principle employed in these fibre modifications to enhance sound absorption is the increase of energy dissipation by increasing the fibre surface area, fibre roughness and tortuosity of the material. This article critically reviews the techniques of modifying the fibrous structures to enhance sound absorption properties and their effectiveness. The sound absorption coefficient of natural fibres can be enhanced up to 0.9 in mid and high frequencies by alkali treatments, while the sound absorption coefficients of microfibres, hollow fibres, bicomponent fibres and nanofibres significantly higher than regular fibres.

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Sound absorption; nanofibres; hollow fibres; bicomponent fibres; plasma treatment; aerogel treatment

1. Introduction

Noise is a global issue and considerable efforts are being made to investigate effective means of developing noise absorbing materials (Bihola & Amin, 2015). Noise absorbers are used to reduce noise level, to control reverberation time or to eliminate echoes for speech intelligibility as well as to prevent sound from being trapped by concave surfaces for promoting fuller sound in concert halls (Na et al., 2007). The main types of materials used for sound absorption are porous absorbers and panel absorbers. Porous absorbers which contain cavities, pores or channels are widely used in acoustic applications. They can be fibrous, granular or cellular materials (Jayamani, 2015).

Textile materials as fibrous absorbers have four major advantages for sound absorption, namely low production cost, small specific gravity, flexibility and promising noise absorbent behaviour (Patnaik, 2016). Conventionally used fibres such as fibreglass, foam and mineral fibres, though have good sound absorption properties, they have health risks and are not environment friendly. Therefore, the use of these fibres is declining while more environment friendly textile fibres such as cellulosic fibres and protein fibres are filling the need (Patnaik, 2016). Sound absorbers are usually graded by the sound absorption coefficient, defined as the ratio of absorbed energy to the incident energy (Zunaidi et al., 2017). Oldham (Patnaik, 2016) investigated the sound absorption properties of natural fibres at 500 Hz frequency. The average noise absorption coefficient (NAC) values were 0.50, 0.40, 0.40, 0.10, 0.20 and 0.20 respectively, for cotton, flax, ramie, sisal, jute and wool fibre based absorbers.

Wool-based building materials are increasingly used due to their low energy consumption and low environmental impact (Borlea (Muresan) et al., 2020). Sheep wool has a comparable sound absorption performance to that of conventional mineral fibres with sound absorption coefficient values over 0.7 (Del Rey et al., 2017). Raw wool is also an alternative to toxic mineral fibre sound absorbing materials (Berardi et al., 2016).

Agricultural by-products such as coir, kenaf and kapok fibres can be successfully used as noise absorbing materials (Tan et al., 2016). Further, recycled paper fibres have demonstrated quite comparable results to other commercial sound absorbers and better performance than coir and polyester fibres (Lim et al., 2018; Sim et al., 2014). The research carried out by Alessandro and Pispola (2005) demonstrated that the sound absorption coefficient of sustainable fibrous materials, kenaf and recycled polyester are slightly lower, but comparable with traditional sound absorbing fibres such as glass wool and rock wool. Mineral fibres such as rock wool and glass wool have sound absorption coefficients close to 1. Since the natural fibre materials in their native form show comparatively low sound absorption properties,

CONTACT Jayawardana Withanage Achini Madushika achinijayawardana1993@gmail.com Department of Textile and Clothing Technology, Faculty of Engineering, University of Moratuwa, Sri Lanka.

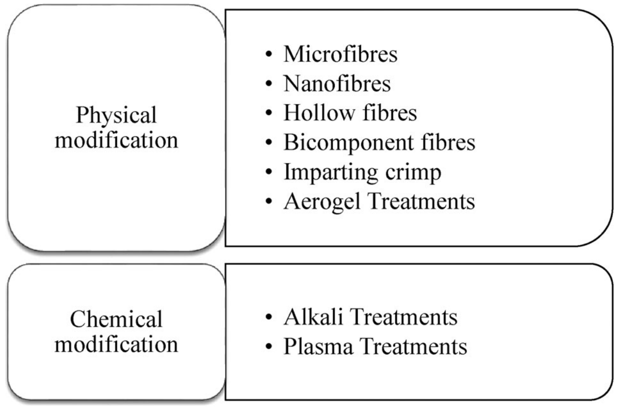

Figure 1. Methods of modification of fibres to enhance sound absorption.

researches are being carried out on new fibre structures and are specifically modified fibres so as to enhance sound absorption properties (Ravandi et al., 2015).

Porous materials allow sound waves to enter into a structure easily. When sound waves travel through the network of interconnected pores within the material, owing to its sound pressure, air molecules oscillate at a frequency of the exciting sound wave. When air molecules interact with tiny fibre walls, kinetic energy of air molecules are converted into heat due to friction of the walls. Furthermore, sound energy dissipation happens due to momentum losses and temperature fluctuations (Mahzan et al., 2009). Therefore, the basic principle of fibre modifications to enhance sound absorption is the increase of energy dissipation by increasing the fibre surface area, fibre roughness and tortuosity of the material. Tortuosity is defined as the elongation of the passageway through the pores, compared to the thickness of the material (Seddeq, 2009).

Sound absorption characteristics of textile fibres can be enhanced by modifying the basic manufacturing technology of fibres or by chemically treating the fibres. Fibre modifications and additional treatments require much lower investment and time than inventing new fibres (Perepelkin, 2005). The treatments in these modifications can be on fibres, yarns or on fabrics. Figure 1 illustrates the techniques available under each of the two categories of modifying the fibrous structures for better sound absorption.

2. Sound absorption property characterisation of physically (structurally) modified fibres

Physical modification of fibres involves altering the supramolecular structure by spinning, drawing and relaxation treatment methods or altering the cross-sectional shape or outer surface of the fibres without modifying the chemical structure (Perepelkin, 2005). Fibre diameter is a significant factor of enhancing sound absorption performance in low-frequency region (Dunne et al., 2017). One of the widely used physical modification methods is to reduce fibre diameter by carefully selecting and executing polymerisation process, polymer spinning and drawing conditions (Ravandi & Valizadeh, 2011). According to Nick et al. (Nick et al., 2002), sound absorption coefficients of lyocell fibre felts and polyester materials were inversely proportional to the fibre diameter. Comparatively, more number of finer fibres was required to obtain a particular density creating more tortuous passages resulting high air flow resistivity. Moreover, movement of finer fibres is easier than thicker fibres at pressure fluctuations.

Alternatively, solid, hollow or multicomponent cross sectional fibres demonstrate various performances (Naeimirad et al., 2018). Bicomponent fibres manufactured by extruding two molten polymers from the same spinneret outlet have been investigated for sound absorbing solutions (Celikel & Babaarslan, 2017). Hollow fibres are produced by an extrusion process which involves forcing a thick, viscous fluid through the holes of a device called a spinneret to form continuous filaments of a semi-solid polymer (Yan et al., 2019). Due to the axial channel along the fibre, hollow fibres demonstrate high sound absorption capability (Mahmoud et al., 2012). Aerogels which are mechanically reinforced with textile fibres is a special class of physical fibre modification method. Treating fibres with aerogels enhance porosity and specific surface area of the fibre structures demonstrating excellent potential on sound absorption (Jaxel et al., 2017).

2.1. Microfibres

Microfibre is 100 times finer than a human hair. A staple fibre or a filament of linear density approximately 1 dtex or less is defined as a microfibre. Microfibres are manufactured by ultrahigh speed spinning methods or by dissolving matrix component of bicomponent fibre (Ravandi & Valizadeh, 2011). Microfibre fabrics exhibit lustre, pleasant softness and handle, good drapability, bulkiness, thermal insulation and have super-absorbent properties such that absorbing over seven times of water in their weight (Ravandi & Valizadeh, 2011).

Microfibre fabrics have superior sound absorption than regular fibre fabrics in all frequencies due to high surface area and improved flow resistance. The level of sound absorption depends on the structure and density of the microfibre fabric (Na et al., 2007). Kucuk and Korkmaz (2015) investigated sound absorption behaviour of different bi-layered nonwoven structures consisting of polyester and polyester/polyamide blends as the top layer, and a variety of base layers. The micro fibrous layer of polyester fibres backed with 70% wool/30% bicomponent polyester fibres demonstrated improved sound absorption properties at all frequencies recording the maximum sound absorption coefficient value of 0.98. Alcaraz et al. (2017) studied the sound absorption properties of nonwoven fabrics with a woven microfibre resistive layer as the top layer and concluded that the sound absorption coefficient drastically improved to a value of 0.9 within the 2300–4000 Hz frequency range.

2.2. Nanofibres

Nanofibres are the fibres having diameters between 50 and 300 nm and manufactured using bicomponent extrusion,

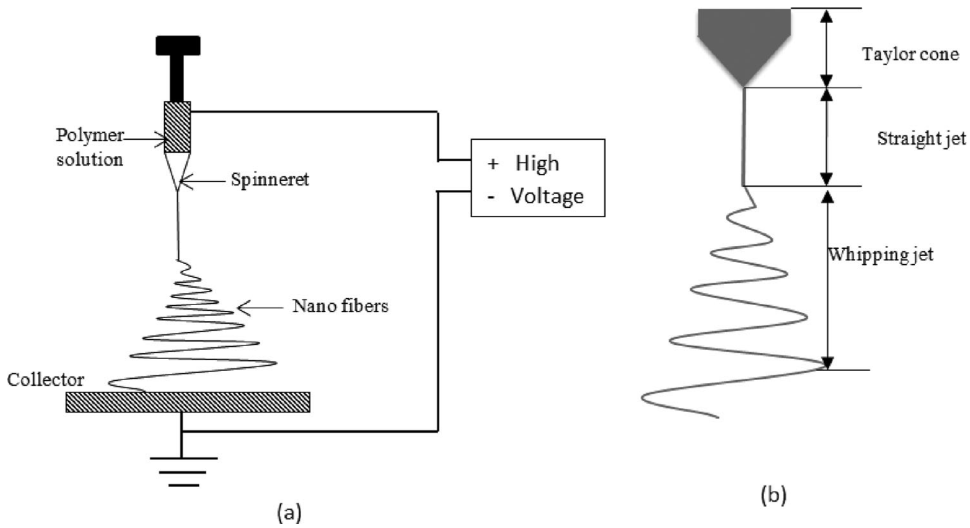

Figure 2. (a) Schematic view of the electro spinning setup (b) Schematic diagram of the polymeric jet path from the needle to the collector.

phase separation, template synthesis, drawing, meltblowing, electrospinning and centrifugal spinning methods. Electrospinning process is widely used due to simplicity to use and its ability to produce nonwoven mats with a high volume to area ratio (Almetwally et al., 2017). During electrospinning, when the applied electric field is increased, the hemispherical surface of the fluid at the tip of the spinneret is stretched and a conical shape is formed (Figure 2). When the electrostatic forces overcome the surface tension due to the applied high-voltage, a charged jet of the solution ejected from the tip of the Taylor cone rapidly accelerates to the grounded collecting target. Normally, the jet is straight near the tip of the spinneret as shown in Figure 2(b), and soon converts into a whipping motion due to electrically driven bending instability (Yan et al., 2019).

Nanofibres significantly improve acoustical properties over conventional materials in low and medium frequency ranges due to high surface to volume ratio and the presence of very fine pores. High surface area of nanofibres increases the frictional contact between the sound wave and the pore walls, thereby converting sound energy into thermal energy (Bihola & Amin, 2015). Kucukali-Ozturk et al. (2017) investigated sound absorption behaviour of polyacrylonitrile (PAN) nanofibre-coated composites manufactured using a novel approach. Polyacrylonitrile (PAN)-based nanofibrous membranes were electrospun over spacer fabrics to produce the composite. The effect of deposition amount of PAN fibres and the number of coated layers was experimentally investigated using 17 and 10 g/m^2 nanofibre membranes. The sound absorption coefficients of the samples having coatings of 17 g/m^2 on both surfaces reached up to 0.7 for the frequency range of 1000–3200 Hz.

Trematerra et al. (2014) studied acoustic properties of nanofibres by gluing a nanofibre layer onto one of the following traditional sound proof materials; glass wool, rock wool, foam, kenaf and polyester. The nanofibre layer is a polymer in formic acid having a concentration of 18% of nylon and has a thickness of 1 µm. The sound absorption coefficient at low and medium frequencies was increased due to gluing of the nanofibre coating, where the nanofibre layer act as a membrane that vibrates at low and medium frequencies due to its nano dimensions. Sound waves impinge on the nano membrane makes it to oscillate and its amplitude becomes a maximum at resonance.

Na et al. (2012) compared sound absorption coefficients of nanofibre fabrics against microfibre fabrics and examined the effect of number of nanofibre layers on regular fibre fabrics for sound absorption. Polyamide nanofibres (diameter 800 nm) obtained from melt spinning process, were converted to nanofibre fabrics through electrostatic process. Those nanofibre fabric layers were plied together to obtain the same area density (mass per unit area of the fabric) as reference samples of microfibre fabrics. The sound absorption effects of nanofibre layers on regular fibre fabric were investigated by placing six layers of nanofibres on a regular fibre fabric. The nanofibre fabrics had better sound absorption than microfibre fabrics within the audible frequency range due to the interaction of sound waves with a large specific surface of nanofibres. This research established the fact that the air friction inside the nanopores and vibrations of the nanolayers improve effectiveness of sound absorbing materials.

Krucińska et al. (2015) showed the potential use of waste natural fibres obtained from spinning mills as a solution for the growing trend towards sustainable acoustic applications. The ultra-short/ultra-fine flax fibres having a fibre length of 6.14 µm and fibre fineness about 0.05 denier obtained from enzymatic treatment were used on its own and standard cotton fibres were used as reinforcement for standard polylactic acid (PLA) fibre matrix. The presence of both ultra-short and ultra-fine flax fibres in the PLA/CO (50/50) nonwoven matrix increased the sound absorption coefficient up to 0.7–0.8 over the frequency range from 2000 to 6400 Hz. Recently, Ulrich and Arenas (2020) found that the sound absorption coefficients of porous bulk materials (melamine foam, polyester textile) can be significantly enhanced by incorporating a nanofibrous membrane as a coating.

2.3. Hollow fibres

Hollow fibres contain an axial channel, which allows air to flow while absorbing noise. The common shapes of the

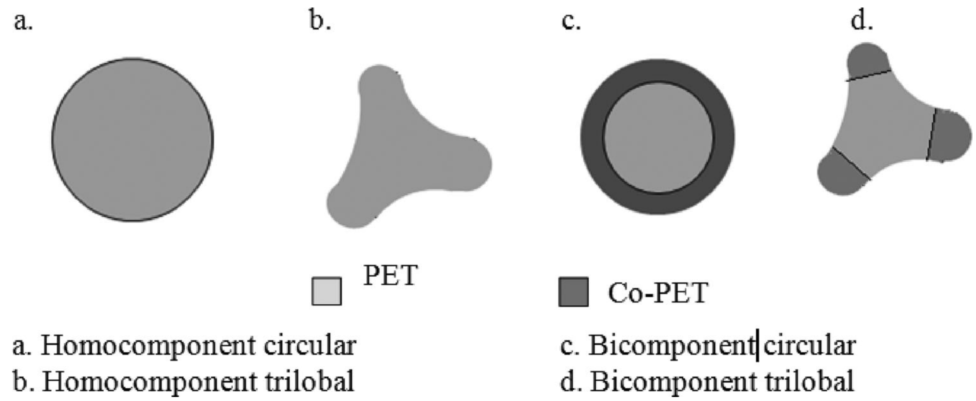

Figure 3. Different fibre cross-sections.

cross sections of the axial channel are round, trilobal, triangular and square. These fibres are of high breathability, light weight, have better cover and possess high heat insulation properties (Ravandi & Valizadeh, 2011). Estabragh fibre is one such natural hollow fibre having a cross section of round shape and having a fibre fineness of 3.38 denier. Even though polypropylene fibres are finer than estabragh fibres, the latter one has high sound absorption due to the hollow fibre structure (Taylor et al., 2014). However, 55.5% of the estabragh fibres are damaged during the carding operation due to lack of cohesion and crimp (Gharehaghaji & Davoodi, 2008). The remedial action commonly practiced to overcome the fibre damages is blending of estabragh fibres with other fibre types (Andrews et al., 1989). Taylor et al. (2014) studied the effect of blend percentage of polypropylene/estabragh blended fabrics on acoustic absorption properties and disclosed that the sound absorption coefficient increases with the increased estabragh fibre percentage.

Kapok fibre is another natural fibre having a hollow structure up to 80–90%, and is widely used in acoustic applications due to its hollow nature (Liu et al., 2015), (Bhattacharya & Bihola, 2019). Jie et al. (2017) studied sound absorption properties of single-hole hollow polyester fibre (SHHPF) reinforced hydrogenated carboxyl nitrile-butadiene rubber composites and the influence of fibre content and thickness of composites on sound absorption properties. A significant increase in sound absorption coefficient was evident in increasing the SHHPF content up to 40% due to increased surface area and tortuous paths. However, beyond 40% of SHHPF, the sound absorption property reduced due to increased density of the composite which suppresses the vibration effect between fibres causing reduction in sound absorption.

Devi (2014) investigated sound absorption properties of solid polyester and hollow polyester blended nonwovens. High percentage of hollow polyester content recorded higher sound absorption coefficient than 100% solid polyester samples. The reason for the direct relationship between hollow fibre percentage and sound absorption efficiency is the structure of hollow fibres. The lumen, which contains the air inside increases the air volume in the fabric and increases its ability to absorb sound (Mahmoud et al., 2012).

2.4. Bicomponent fibres

Bicomponent fibre is a special type of fibre that consolidates two polymers in one fibre (Takematsu et al., 2018). When manufacturing nonwovens from bicomponent fibres, one of the polymers melted earlier and adhered to adjacent fibres creating a rough fibre surface. Sound absorption of bicomponent fibre layers is higher than the homocomponent analogs due to higher bonding and decreased air permeability (Celikel & Babaarslan, 2017). Celikel and Babaarslan (2017) analysed the effects of bicomponent fibres on sound absorption properties of multilayer nonwoven fabrics. This study was carried out on polyester fibre nonwovens having three layers made out from polyester fibres of four different cross-sectional types (homocomponent round (R), homocomponent trilobal (T), bicomponent round (Bi-R) and bicomponent trilobal (Bi-T)). These four types of cross sections are presented in Figure 3.

The composition of bicomponent fibres was 90% polyester (PET) core having melting point of 230–250 °C and 10% co-polyester sheath having melting point of 110–140 °C. Co-polyester is also a type of polyester which has been produced using more than one diacid or diol in the polymerisation process. According to the test results, multilayer nonwovens with bicomponent fibres as outer layer have better sound absorption than nonwoven structures with homocomponent fibres due to higher bonding and decreased permeability. During the calendering process, co-polyester fibres melt earlier and adhered to adjacent fibres increasing frictional losses of sound energy (Celikel & Babaarslan, 2017).

2.5. Imparting crimp to the fibres

Crimp or waviness of a fibre is defined as the degree of deviation from linearity of a non-straight fibre. Natural fibres like cotton have a natural crimp, but for manmade fibres, artificial waviness should be introduced to obtain better cohesion and friction (Maity, 2014). Imparting crimp to the fibres encourages increasing the amount of air trapped by the fibres and tortuous paths resulting better sound absorption. Crimped fibres are manufactured using a variety of techniques including stuffer box crimped, gear crimped, helically crimped and combination of thereof (Thompson et al., 2018).

Crimp is measured by several parameters such as wavelength, crimp length, crimp frequency, crimp angle, crimp index, crimp amplitude and crimp degree. Crimp frequency is defined as the number of crimp bows or waves per unit length of straightened fibre (Maity, 2014). Panahi et al. (2015) studied the effect of crimp frequency on sound absorption coefficient of batts (large fibre sheets layered using a laboratory carding machine) comprised staple polypropylene fibres with crimp frequencies of 1.9, 2.3 and 3.6 crimp per cm and found that higher crimp frequency results in higher sound absorption. The highest sound absorption coefficient observed was 0.78 for the crimp frequency of 3.6. When the crimp frequency of samples was increased for constant weight, it was resulted shorter straight fibre lengths and more number of creases along the fibres reducing the available surface for sound reflection. Increasing fibre crimp led to higher tortuosity offering a higher resistance against the sound waves. The increased resistance due to tortuous passages is the main reason for the increase in sound absorption.

2.6. Treating fibres with aerogels

Aerogel is an extremely low dense solid obtained from removing the liquid component of a gel through supercritical drying (Sagar & Babasaheb, 2018). Aerogels are generally endowed with a high specific surface area, very high porosity, low bulk density, outstanding textural properties and inflammability. Aerogels mechanically reinforced with textile fibres unveils excellent potential on sound absorbing applications due to loosely packed open porous networks (García-González et al., 2019).

Yang et al. (Yang et al., 2019) investigated the sound absorption performance of single and laminated layers of polyester/polyethylene nonwovens embedded with hydrophobic amorphous silica aerogel. The sound absorption coefficient of single layer aerogel/polymer nonwovens lie between 0.0556 and 0.0858 implying its inefficiency as sound absorbers. However, the sound absorption coefficient of two layer sample of laminated aerogel/polymer nonwoven reached to its maximum value of 0.9978 at 4136 Hz. Oh et al. (2009) investigated the sound absorption and thermal insulation properties of PET/Aerogel blanket, manufactured using two methods. The first method was direct gelation of silica on PET by dipping and swelling PET nonwoven fabric in Ortho Silicate (TEOS)/ethanol mixture, while controlling the pH of reaction media to 2.5 using HCl to promote hydrolysis. After acid hydrolysis, pH was controlled to above 7 with NH_4OH for condensation. The second method was the dipping of PET nonwoven fabric in the dispersion of Silica hydrogel. At frequencies above 1000 Hz, sound absorption coefficient of PET/Aerogel blanket manufactured by direct gelation of a large amount of silica on PET increased steadily and reached to a maximum of 0.4. If mechanical properties of aerogels are improved and the production cost is reduced, aerogels can become a good alternative for conventional sound absorbers (Bheekhun et al., 2013).

3. Sound absorption property characterisation of chemically modified fibres

Fibre structures are chemically modified immediately before spinning or at the stage of processing finished fibres by adding new functional groups to react with the fibres (Perepelkin, 2005).

3.1. Alkali treatment

Fibre type, chemical constituents, morphology and surface treatment of fibres, highly affect sound absorption behaviour of materials (Nasidi et al., 2018). Surface roughness of fibres can be increased to dissipate sound energy and increase energy loss (Cao et al., 2018). Plasma and sodium hydroxide treatments are commonly used treatments to reduce fibre diameter and these treatments enhance interfacial bonding by mechanical interlocking of natural fibres. Treating natural fibres with NaOH reduces fibre diameter by removing hemicellulose, lignin and waxy impurities on the fibre surface. Furthermore, dissolving lignin creates pores on the fibre surface (Oushabi et al., 2017). Sound absorption coefficient of natural rubber foams (maximum value – 0.4) can be enhanced up to 0.9 in mid and high frequencies by adding sodium hydroxide treated bagasse fibres and oil palm fibres (Tomyangkul et al., 2016).

Sari et al. (2016) reported sound absorption properties of raw and alkali-treated corn husk fibres that were alkali modified by 1%, 2%, 5% and 8% of sodium hydroxide. Corn husk fibres were soaked in NaOH for 2 h at standard temperature and relative humidity. The maximum sound absorption coefficient of raw fibres was 0.93. The alkali-treated fibres showed an improved sound absorption coefficient of 0.98–0.99 in the frequency range of 1.6–3.25 kHz. Alkali treatments reduce fibre diameter by removing lignin and hemicellulos. As a result, airflow resistivity increases, and porosity decreases due to more number of fibres occupied in a unit volume.

3.2. Plasma treatment

Plasma is a mixture of electrons, radicals, ions, atoms, molecules and different excited particles that react with fibre surface and modify chemical and physical properties. Plasma treatment changes the surface morphology of the fibres and increases the surface area of fibres altering sound absorption of materials depending on the fibre type (Sun, 2018). Na and Cho (2010) observed that the sound absorption coefficients of regular and hollow polyester fibres were increased by 0–4.6% and 11.6–12.5%, respectively, by treating with plasma. Plasma treatment increased the roughness of fibre surface and it was more prominent in hollow polyester fibres than regular fibres because of high specific surface area. Plasma treatments may change the sound absorption properties if over treated. When the plasma treating time on jute fibres exceeds by 3 s, the sound absorption coefficient was reduced due to fibre damage and weight loss. After lignin was removed by the plasma treatment, poorly bonded

Table 1. Characteristics of physically modified fibres over solid fibres (Dasdemir et al., 2012; Maity, 2014; Ravandi & Valizadeh, 2011; Zhu et al., 2017).

Microfibres	Nanofibres	Hollow fibres	Bicomponent fibres	Crimped fibres
Low density	Relatively high production rate and simplicity	More resilience/recovery	Improved self-bonding in nonwovens	High abrasion resistance
Good drapability	Low density	More bulky and fluffy	Better flexibility	Better cover
Pleasant softness and handle	Higher breathability	Higher absorption of water and perspiration	High strength	More bulky
Lustre		Better cover		High cohesion
High strength		Lighter in weight		Pleasant softness and handle
Higher absorption surface		Higher heat insulation		

carbohydrate-rich fibres destroyed easily from the surface, exposing new lignin to further degradation reactions. Kenaf fibre is stronger than jute. Treating kenaf fibre with plasma for 6 s, increased sound absorption coefficient by 4.6–9.4% (Na & Cho, 2010). Pavlovic et al. (2019) investigated acoustical properties of natural cellulose fibrous materials treated with low-pressure radio-frequency argon plasma. The sound absorption coefficients of both randomly and directionally oriented fibre arrangements were enhanced by the plasma treatment.

4. Discussion

A collection of interactive properties of fibres, yarns and fabrics creates the sound absorption property in textile materials (Sun, 2018). This review article focussed on methods of modifying fibre properties to enhance sound absorption of textile fibres and effectiveness of these modifications. Due to health risks associated with traditional fibres, acoustic industry has focussed on textile fibres for sound absorbing solutions. However, textile fibres in their native form show comparatively low sound absorption properties to mineral fibres which have an average sound absorption coefficient close to 1. The textile fibres can be modified using chemical or physical techniques in order to use as more effective sound absorbers (Ravandi et al., 2015). It is clearly demonstrated that the average sound absorption coefficient of the textile fibres/fibre structures can be increased up to 0.8–0.9 by changing the chemical structure and morphology of the constituent fibres, using chemical and physical modifications such as microfibres, nanofibres, hollow fibres, bicomponent fibres, crimped fibres, plasma treatment and alkali treatment.

Fibre type and the performance requirements of the end product are the most crucial specifications which determine the fibre modification method. Synthetic fibres can be modified as microfibres, nanofibres, hollow fibres, bicomponent fibres and crimped fibres in the spinning stage to achieve an optimised sound absorbing coefficient of 0.78–0.98. Inherited characteristics of each physical modification method are presented in Table 1. Fibre modification method of manmade fibres should be selected according to fibre type and performance requirements of the end product with the aid of past researches discussed in the review.

The use of natural fibre products for sound absorption is much safer than synthetic fibres (Yahya & Chin, 2017). However, the average NAC values were 0.50, 0.40, 0.40, 0.10, 0.20 and 0.20, respectively, for cotton, flax, ramie, sisal, jute and wool fibre-based absorbers at 500 Hz frequency (Patnaik, 2016). The alkali treatment can enhance sound absorption coefficient of natural fibres up to 0.9–0.99 due to reduction of fibre diameter by removing hemicellulose, lignin, and waxy impurities on the fibre surface. Furthermore, dissolving lignin creates pores on the fibre surface (Oushabi et al., 2017).

Sound absorption coefficient of both synthetic and natural fibres can be increased using plasma treatment, while controlling the treatment time according to the fibre type. By treating regular polyester fibres, hollow polyester fibres and kenaf fibres with plasma can increase the sound absorption coefficient by 0–4.6%, 11.6–12.5% and 4.6–9.4%, respectively (Na & Cho, 2010). Plasma treatment is an environmental friendly surface modification process due to low chemical consumption and short processing time. Furthermore, mechanical properties of fibres such as maximum tensile strength and elongation at break are positively affected by the plasma treatment (Sun, 2018).

5. Conclusion

Modification of textile fibres using chemical and physical methods such as microfibres, nanofibres, hollow fibres, bicomponent fibres, crimped fibres, plasma treatment and alkali treatment significantly enhance sound absorption property. The performance of modified fibre structures show comparable sound absorption coefficients of traditional materials used in sound absorption. The method of modification should be selected according to the fibre type and performance requirements of the end product. Traditional toxic sound absorbing materials can be replaced by textile fibrous materials with enhanced sound absorptivity by modifying fibres chemically or physically.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Jayawardana Withanage Achini Madushika http://orcid.org/0000-0002-5278-085X

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