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A Market Research on the Development Trends of Aerogel Daily Clothing

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Abstract: The objective of this study is to analyze the development trends of aerogel daily clothing through market research, and to discuss the main points of future aerogel application in daily clothing. Market research on daily clothing has been conducted by collecting relevant information on the internet and analyzing the content of the information. We summarized the market research results in three aspects: the daily clothing brand using aerogel, the aerogel composite used in daily clothing, and the property of aerogel daily clothing. From these results, it can be seen that the development of aerogel daily clothing is becoming active and specialized. But there are still many difficulties due to lack of development experience. One problem is that the application methods of aerogel composite in current aerogel daily clothing are similar. Another problem is that the analysis of consumer reviews can only provides a rough understanding of the property of aerogel daily clothing. Therefore, further application research of aerogel composite in the field of daily clothing through scientific evaluation is required. It is expected to improve the performance of the aerogel daily clothing and increase the utilization of aerogel composite by conducting the further application research.

Key words: aerogel daily clothing, market research, development trend, aerogel composite, property

1. Introduction

Aerogel was first reported in a paper submitted to Nature by Kistler (1931) as a low-density, porous solid gel derived from gel. Aerogel can be synthesized not only from silicon oxide (silica aerogel), but also from a variety of organic and inorganic substances such as titanium oxide, aluminium oxide, and carbon (Venkataraman et al., 2016). Silica aerogel have drawn a lot of interest both in science and technology because of their low bulk density (up to 95% of their volume is air), hydrophobicity, low thermal conductivity, high surface area, and optical transparency (Gurav et al., 2010).

However, from the viewpoint of applications, aerogel have the drawback that they absorb moisture from the atmosphere, they are fragile, they cannot be easily handled, and they cannot be used to insulate complex shaped bodies (Katti et al., 2006). So, in order to provide a product with high durability, the aerogel is infiltrated into fibrous substrates, usually non-woven fabric blankets, resulting in a flexible, drapeable aerogel composite. This product, an 'aerogel blanket', was first developed in 1999 by Aspen Systems (Venkataraman et al., 2016), these materials have applications in aerospace, military cryogenic applications, oil and gas processing industry, and construction (Perez, 2012). In order to save energy, the demand for advanced insulation materials is increasing, and the use of aerogel composite, including aerogel blanket, is expanding the aerogel market. A report by Collins of IDTechEx Research (2018) predicts that the revenue of aerogel composite will exceed $200 million in 2017 and reach $600 million in 2027. With the unpredictability of oil prices and the inevitable cutbacks already being observed, it is important that aerogel manufacturers do look to broaden their application horizons. These applications are diversifying with roles in building and construction, district energy, apparel and footwear, sporting goods, aerospace and automotive (Collins, 2018).

In recent years, aerogel is becoming a new research hot spot in the field of protective clothing (Zhang et al., 2017), it finds applications in the construction of heat and flame resistant protective clothing for industrial workers, for protection against thermal hazards of an electrical arc, protective clothing for workers exposed to molten substances and related hazards, and firefighter protective clothing (Chakraborty et al., 2016). And in the field of daily clothing, interest in the application of aerogel composite is growing. The application expansion of aerogel composite depends heavily on production costs. However, due to the complexity of the aerogel manufacturing process, aerogel composites have always maintained high production costs. It was not until 2006 that the production costs was greatly reduced when a simplified method 'One day synthesis' was made to manufacture aerogel by Bhagat et al.

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(2006). Since then, the development of aerogel daily clothing has become active. If aerogels can be used extensively in daily clothing as a thermal insulation material, it will reduce the use of animal fur, and will be beneficial for the maintaining the earth's ecology.

In the early days, studies on the clothing using aerogel were mainly carried out in the space suit and diving suit field. Paul and Diller (2003) and Tang et al. (2003) conducted the studies on space suit, Bardy et al. (2006) and Nuckols et al. (2009) conducted the studies on diving suit. Since 2013, studies on the clothing using aerogel were mainly carried out in the firefighter's protective clothing field (Hu, 2013; Kim et al., 2018; Lu et al., 2013; Qi et al., 2013; Shaid et al., 2016; Zhang et al., 2013).

However, in the field of daily clothing, which has a higher demand in aesthetic and convenience, there is still no study on aerogel application. In order to carry out the study of aerogel application in the daily clothing field, it is necessary to understand the development trends of aerogel daily clothing on the market. This study aims to analyze the development trend of aerogel daily clothing through market research, and to discuss the main points of future study on aerogel application in daily clothing based on market research results.

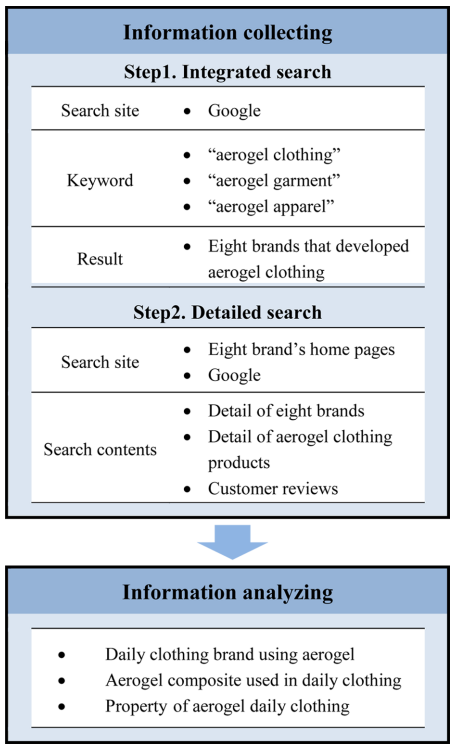


Fig. 1. Process of the market research on development trends of aerogel daily clothing.

2. Method

A market research on aerogel daily clothing was conducted by collecting the related information on the internet and analyzing the information contents in this study.

The information collecting stage was divided into two steps: integrated search step and detailed search step. In the integrated search step, we collected related information with the key words such as 'aerogel clothing', 'aerogel garment' and 'aerogel apparel' through search engine Google to get a comprehensive look at the global market of the aerogel daily clothing. In order to get exact matching results, we have searched the key words by putting double quotation marks (" ") according to Common Search Techniques of Google Search Help. As of February 8, 2018, the number of information about "aerogel clothing" was 1070, about "aerogel garment" was 56, and about "aerogel apparel" was 324. By browsing through the retrieved information in turn, we extracted nine clothing brands that used aerogel to develop daily clothing, including Champion, ROCKY, PeakPerformance, FACTION, Shiver Shield, Lukla, OROS, SNAFEL, and AG. Among the nine brands, Lukla and OROS were launched in the same company. The company launched aerogel daily clothing in the name of Lukla in 2015 and improved its products after considering consumer opinions. In 2016, it relaunched aerogel daily clothing in the name of OROS. According to this situation, Lukla and OROS were regarded as one brand, and information of the two brands was collected in OROS name. That was to say, this study analyzed eight brands that developed aerogel daily clothing. In the detailed search step, detailed information of the brands, detailed information of all the aerogel daily clothing products and consumer reviews about the aerogel daily clothing were collected by re-searching on engine Google and homepages of the eight brands extracted in the integrated search step. All of the detailed information collected was used to analyze the results of market research.

The Information analyzing stage summarized the results of market research on the development trends of aerogel daily clothing, including brand information and product information of daily clothing brand using aerogel, types and application methods of aerogel composite used in daily clothing, and warmth property and breathability property of aerogel daily clothing. The process of conducting the market research on development trends of aerogel daily clothing was shown in Fig. 1.

3. Results & discussion

3.1. Daily clothing brand using aerogel

3.1.1. Brand information

Brand information, including founding year, registered area,

Table 1. Information of the daily clothing brands using aerogel

Brand \ Information	Founding year	Registered area	Company name	Starting year of development
Champion (MVC)	1919	America	HANESBRANDS INC.	2010
ROCKY (MVC)	1979	America	ROCKY BRANDS, INC.	2012
PeakPerformance (MVC)	1986	Europe	Peak Performance Sports & Fitness Center, Inc.	2013
FACTION (MVC)	2005	Europe	The Faction Collective SA	2014
Shiver Shield (SAC)	2011	America	Shiver Shield, L.L.C.	2011
OROS (SAC)	2015	America	Lukla LLC	2015
SNAFEL (SAC)	2017	China	Shanghai SNAFEL Material Technology Co., Ltd.	2017
AG (SAC)	2017	China	Shenzhen Aerogel Technology Co., Ltd.	2017

MVC: multi-variety clothing, SAC: special aerogel clothing

company name, and starting year of development of aerogel daily clothing, was gathered and summarized in Table 1. Eight brands were numbered 1 through 8 for convenience. 'MVC' marking in the table column of 'brand' is the abbreviation of 'multi-variety clothing' which means a brand that sells various kinds of clothing, and 'SAC' is the abbreviation of 'special aerogel clothing' which means a professional brand that is established for developing aerogel daily clothing.

Among the eight brands, there were four MVC brands and four SAC brands, and all of MVC brands were founded earlyer than SAC brands. The registered areas of these brands were mainly in the America, Europe and China, and America was the most registered place. The company of OROS has developed an aerogel composite named SOLARCORE before developing aerogel daily clothing, and the companies of SNAFEL and AG were both manufacturers of aerogel materials. The brands founded by aerogel materials manufacturers were all SAC brands. In other words, the aerogel materials manufacturers only developed aerogel daily clothing. From these phenomenons, it would be thought that the manufacturers attach great importance to the application of aerogels in daily clothing because daily clothing can be used in a wide range. If aerogels can be widely used in the field of daily clothing, the market demand for aerogels will be greatly increased. From a point of the starting year of development of aerogel daily clothing, almost every year a brand began to develop aerogel daily clothing from 2010 to 2017.

3.1.2. Product information

The product information such as the development year, type and quantity of the aerogel daily clothing products was gathered and summarized in Table 2 for all of the eight brands that developed the aerogel daily clothing. Development year of aerogel daily clothing products was marked by the year in which new products were launched. Type of aerogel daily clothing products were classified as jacket, pant, vest, midlayer, and accessory depending on the type of clothing, and re-classified as men's (M), women's (W), and unisex (U) depending on gender. Because the development status of every brand was different, it is marked as ' □ ' for the aerogel daily clothing products that were being sold during the time of the market research.

Champion was the first brand that developed clothing using aerogel in the field of daily clothing. It had developed an aerogel jacket and tested it as a part of the clothings for climbing Mount Everest. The aerogel jacket was used up to 24,000 feet, and in temperatures as low as -40ºC. Expedition leader Jamie Clarke described it as the warmest coat he'd ever worn, even so, it's extremely expensive, with previous jackets that use aerogel running as much as $2000 (Becker, 2010). Champion finally gave up to launch the aerogel jacket to the market. ROCKY launched its two products of aerogel daily clothing in 2012, and the two products were sold continuously from the launching up to the present. During the market research, almost all of the products of aerogel daily clothing of ROCKY have been sold out. It is worth noting that the brand didn't develop new products of aerogel daily clothing. PeakPerformance and FACTION developed and sold the new products of aerogel daily clothing almost every year. Shiver Shield has continually sold its first batch-developed products of aerogel daily clothing up to now. In 2017, Shiver Shield developed the second batch products of aerogel daily clothing, which was a new category, and sold them with the first batch together. OROS developed the first batch products of aerogel daily clothing under the name Lukla in 2015, then improved its products after considering consumer opinions, and began to sell them under the OROS name in 2016. SNAFEL and AG that appeared in 2017 need to be further observed since their aerogel daily clothing products were launched still less than a year.

The total number of products developed by the eight brands was 59, among them, 28 jackets accounted for 47.5%, 12 pants accounted for 20.3%, 3 vests accounted for 5.1%, 4 midlayers accounted for

Table 2. Product information of the daily clothing brands using aerogel

Brand	Development year	Jacket			Pant			Vest			Midlayer			Accessory			Number of product		
		M	W	U	M	W	U	M	W	U	M	W	U	M	W	U			
Champion (MVC)	2010	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	
ROCKY (MVC)	2012	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	[2]	2	
PeakPerformance (MVC)	2013	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2		
	2014	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	5	18
	2016	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[1]		[5]
FACTION (MVC)	2014	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	4		
	2015	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	4	10	
	2016	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	[2]		
Shiver Shield (SAC)	2011	3	2	-	3	-	-	-	-	-	-	-	-	-	-	2	[10]	12	
	2017	-	-	-	-		-	-	-	-	-	-	-	-	-	2	[2]		
OROS (SAC)	2015	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	19	41
	2016	3	3	-	-	1	1	1	1	-	2	2	-	-	1	2	[17]		[39]
SNAFEL (SAC)	2017	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	[2]	2	
AG (SAC)	2017	1	1	-	-	-	-	-	1	-	-	-	-	-	1	4	[8]	8	
Subtotal		18	10		9	2	1	1	2		2	2			2	10	[44]	59	
Total		28 (47.5%)			12 (20.3%)			3 (5.1%)			4 (6.8%)			12 (20.3%)				

□ : The aerogel daily clothing products being sold at the time of the market research.

6.8%, and 12 accessories accounted for 20.3%. As a result, jacket was the most developed type of aerogel daily clothing. In addition, quantity of the men's jacket was 18, more than that of the women's jacket.

The total number of the products developed by the MVC brands was 18, and developed by the SAC brands was 41. In total number of the products being sold at the time of the market research, the MVC brands was 5, and the SAC brands was 39. It can be seen that SAC brands were more active in the development of aerogel daily clothing than MVC brands. Usually, clothing brands will reduce or stop products that are not significantly profitable, just like the development trend of aerogel daily clothing displayed in the MVC brands. While for the development of aerogel daily clothing, the SAC brands showed the opposite trend. But this does not mean that the products of aerogel daily clothing have brought considerable profit to the SAC brand. Since the SAC brands are usually founded by aerogel material manufactures specifically for the development of aerogel daily clothing, even if they are not yet have considerable profit, the brands still have the intention to carry out research and exploration. This trend indicates that even though the market has a lot of interest in the development of aerogel daily clothing, the development is still inexperienced and has many difficulties.

3.2. Aerogel composite used in daily clothing

3.2.1. Types of aerogel composite

All aerogel materials used in the development of aerogel daily clothing of the eight brands were developed by combining aerogels with other materials such as nonwovens, polymeric materials, and the like. For the sake of clarity and simplification of the description, in this study, they were collectively referred to as 'aerogel composite'. The detailed information of the aerogel composite used in daily clothing such as the brand, type, company was gathered and summarized in Table 3. The aerogel composite brand Zero-loft^{TM} used by Champion was no longer available, according to information displayed on JUSTIA, a professional website that provides legal information search in the United States. The specific information related to the aerogel composite brand SNAFELR used by SNAFEL was not disclosed in Table 3, the 'nano aerogel composite materials' marked on the brand homepage was directly cited.

Three types of aerogel composites have been used to develop daily clothing, namely 'silica aerogel + non-woven fabric', 'silica aerogel + flexible polymer' and 'Nano aerogel composite', and their images were shown in Table 4. Because the images of aerogel composite used by Champion and FACTION couldn't be found, they were omitted in Table 4; and about the 'nano aerogel composite materials' used by SNAFEL, only an explanatory drawing was found.

The type of 'silica aerogel + non-woven fabric' composite most used in the development of aerogel daily clothing was commonly called 'aerogel blanket'. It was first developed in 1999 and has been used widely in various fields because of its low thermal conductivity, excellent flexibility and high performance insulation

Table 3. Detailed information of the aerogel composite used in daily clothing

Brand	Type of aerogel composite	Brand of aerogel composite	Company of aerogel composite
Champion	Silica aerogel + non-woven fabric	Zero-loft^{TM} (×)	Element 21 Corporation
ROCKY	Silica aerogel + non-woven fabric	AEROTHERM®	Aerogel Technologies Corp.
PeakPerformance	Silica aerogel + non-woven fabric	AEROTHERM®	Aerogel Technologies Corp.
FACTION	Silica aerogel + non-woven fabric	-	-
Shiver Shield	Silica aerogel + non-woven fabric	-	-
OROS (Lukla)	Silica aerogel + flexible polymer	SOLARCORE®	Lukla LLC
SNAFEL	'Nano aerogel composite materials'	SNAFEL®	Shanghai SNAFEL Material Technology Co., Ltd.
AG	Silica aerogel + non-woven fabric	AG®	Shenzhen Aerogel Technology Co., Ltd.

(Venkataraman et al., 2016). This type of aerogel composite was often used after encapsulation because the aerogel particles adhering to the aerogel blanket were easily peeled off and scattered in the air (Table 4-image1, 2). However, encapsulated aerogel composite generally had the following disadvantages: one was that the clothing become less flexible or even rigid, the second was that it cannot be cut and sewn directly, and the third was non-breathability.

AG aerogel blanket was also the type of 'silica aerogel + non-woven fabric' composite that was developed in 2017 with an emphasis on material flexibility. The newly developed AG aerogel blanket had the foldable characteristics that previous similar materials did not have, which improved this type of aerogel composite's usability in the field of daily clothing (Table 4-image 3).

Even though the flexibility was improved greatly, the encapsulated composite of 'silica aerogel + non-woven fabric' was yet disadvantageous to use. Researchers of OROS developed a new type of aerogel composite of 'silica aerogel + polymers' that could be cut and sewn. This kind of aerogel composite developed by a unique method called 'aerogel-infused closed cell polyfoam' and produced under the name 'SOLARCORE' (Table 4-image 4).

However, SOLARCORE also did not solved the non-breathability disadvantages of encapsulated 'silica aerogel + non-woven fabric' composite. SNAFEL was working to improve the breathability of aerogel composite, as could be seen from the explanatory drawing of 'Nano Aerosol Composite materials' presented on its homepage (Table 4-image 5).

3.2.2. Application methods of aerogel composite

Aerogel composite was often used for the warmth in the field of daily clothing, usually controlled the warmth property of aerogel daily clothing by changing the covering area of aerogel composite. According to the covering area, the application method of aerogel composite was classified into full covering method and partial covering method. And the partial covering method was subdivided into insulation panel inserting and insulation pattern cutting according to the type of the aerogel composite. In order to visually understand, the diagrams marked with the location and area of aerogel composite, and the real images of aerogel daily clothing were presented in Table 5. The parts of aerogel composite were marked in gray color in the diagrams.

Table 4. Types of the aerogel composite used in daily clothing

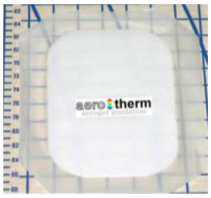
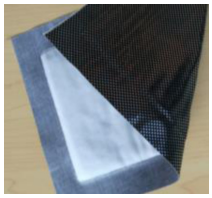
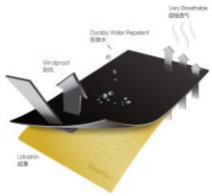
Type	Silica aerogel + non-woven fabric			Silica aerogel + flexible polymer	'Nano aerogel composite materials'
Brand	ROCKY PeakPerformance	Shiver Shield	AG	OROS	SNAFEL
Image					
	Image 1. AEROTHERM insulation panels. *www.aerotherm-insulation.com*	Image 2. Be applied by ShiverShield. *www.shivershield.com*	Image 3. AG-T series aerogel cloth. *www.agel-tech.com*	Image 4. SOLARCORE aerogel. *www.kickstarter.com*	Image 5. SNAFEL nano aerogel composite materials. *www.snafel.cn*

Table 5. Application methods of aerogel composite in daily clothing

Full covering method	Partial covering method	
	Insulation panel inserting	Insulation pattern cutting
		
OROS Men's Parka. *www.orosapparel.com*	Faction Darwin Jacket 2017. *https://www.powder.com*	OROS Men's Discovery Fleece. *www.orosapparel.com*

The full covering method was a method of using aerogel composite in all area of the clothing. It was the most anticipated application method when using aerogel composite in daily clothing since the insulation role of aerogel composite could be maximize for achieving the goal of adapting to the extremely low temperature environment with a minimum amount of clothing. However, the development of aerogel daily clothing by this method was difficult due to the high production cost caused by the difficulty of aerogel processing. In addition, the breathability of the aerogel daily clothing developing by this method was very poor. In order to improve the problem of poor breathability, the main method adopted was to form vents that could be opened and closed by providing a zipper at the position such as armpit, crotch and side seam.

The partial covering method was to apply aerogel composite on only a part area of the clothing. One of partial covering method was 'insulation panel inserting', which meant to use the encapsulated 'silica aerogel + non-woven fabric' composite. In this way, the aerogel composite was often fixed directly to the lining or attached to a separate detachable endothelium as a role to enhance the warmth of the original garments made by other insulating materials. The other partial covering method was 'insulation pattern cutting', which meant to use the 'silica aerogel + polymer' composite, the composite could be directly made into clothing patterns because it could be cut and sewed freely, and no encapsulation was required. This insulation pattern cutting was used only by OROS at present.

3.3. Property of aerogel daily clothing

Aerogel daily clothing were mainly the clothing that gives a cold protection function such as ski suit and mountaineering suit, and the important property for these kinds of clothing was warmth and breathability. In order to examine the warmth and breathability property of the current aerogel daily clothing, consumer reviews were collected and analyzed. The collecting of consumer reviews focused on the jacket which the most developed aerogel daily clothing type. Through the brands' homepage, online shopping malls of Amazon (https://www.amazon.com) and Taobao (https://taobao.com), and crowd funding website Kickstarter (https://www.kickstarter.com), 528 consumer reviews were collected. By reading the 528 consumer reviews one by one, 41 relevant consumer reviews that related warmth and breathability property were extracted, the rest was related to shipping, sewing, and size etc. Thirty-two reviews were related to the clothing developed by the full covering method and nine reviews were related to the clothing developed by the partial covering method. Then all the words relating to the warmth and breathability property of aerogel daily clothing were extracted, and the frequency of each relevant word was summarized as shown in Table 6.

Most consumers worn the aerogel daily clothing under the environment that was below zero and windy such as working out of doors, skiing, mountain climbing and hunting, also a few consumers worn it to go to office in winter.

Evaluation about the warmth property of aerogel daily clothing was generally 'warm', and many of the consumers who had such evaluations mentioned that the windproof effect of the clothes was good. There were also a few evaluations of 'too warm' and 'chilly' in the consumer reviews on the aerogel daily clothing by full covering method. The 'too warm' feeling of consumers was usually caused by strenuous exercise, even if they were in a low temperature environment or caused by an environment above zero, even if they were exercising lightly like walking. A light exercise in a low temperature environment or staying in one place for a long time usually caused the 'chilly' feeling of the consumers. The responses were insufficient in the partial covering method, and there were no the evaluations like 'too warm' or 'chilly' in the customer reviews. It was found that it was not easy to evaluate the role of aerogel composite when it was as a part of all thermal insulations in aerogel daily clothing.

Evaluation about the breathability property of aerogel daily clothing was generally 'not breathable', and the 'not breathable' evaluation were mainly from the consumer reviews of the aerogel

Table 6. Customer reviews about the property of aerogel daily clothing

Application methods of aerogel composite		Full covering method	Partial covering method
41 relevant consumer reviews extracetd		32	9
Property of aerogel daily clothing	Relevant words	Frequency of the relevant word	
Warmth	Warm	30	8
	Windproof	11	3
	Too warm	8	-
	Chilly	4	-
Breathability	Not breathable	6	1
	Vents work well	2	1
	Vents work, but not breathable	1	0
	Breathe well	-	1

(multiple responses)

daily clothing developed by full covering method. Vents often were installed to improve the breathability of aerogel daily clothing, but a consumer said that the clothing microclimates were not well controlled through vents.

The warmth and breathability property of aerogel daily clothing can be known roughly through the qualitative analysis of the consumer reviews. However, due to the individual differences in the wearer's wearing experience and the wearing environment, and there is no uniform rating scale in consumer reviews, more specific analysis cannot be performed. For the further development of aerogel daily clothing, a standard scientific analysis through the physical and objective evaluation is required.

4. Conclusion

In this study, we researched the development trends of aerogel daily clothing by conducting market research based on internet information for increasing the utilization of aerogels in the field of daily clothing. In the market research, the daily clothing brand using aerogel, the aerogel composite used in daily clothing, as well as the property of aerogel daily clothing was examined.

Eight brands including Champion, ROCKY, PeakPerformance, FACTION, Shiver Shield, OROS, SNAFEL and AG developed aerogel daily clothing between 2010 and 2017. These brands contained 4 MVC brands that sold various kinds of clothing, and 4 SAC brands that were established for develpoing aerogel daily clothing. All of the aerogel daily clothing products that were developed by the brands were mainly the clothing that provided a cold protection in the low temperature environment, such as ski suit and mountaineering suit. They were classified as jacket, pant, vest, midlayer and accessory, and jacket was the most developed type of aerogel daily clothing.

Three types of aerogel composites were used in daily clothing, and they were continuously upgraded in performance. The upgrading was focusing on further improvements in flexibility to facilitate the processing of the product as well as improvements breathability and lightweight to improve wearing comfort. Of course, the performance of aerogel composite can directly affect the property of aerogel daily clothing. In addition, the application method of aerogel composite is also an important factor affecting the property of aerogel daily clothing. The application methods of aerogel composite currently used in daily clothing could be divided into the full covering method and the partial covering method.

The property of aerogel everyday clothing in terms of warmth and breathability in consumer reviews was analyzed. Evaluation about the warmth property of aerogel daily clothing was generally 'warm', and many of the consumers who had such evaluations mentioned that the windproof effect of the clothes was good. Evaluation about the breathability property of aerogel daily clothing was generally 'not breathable'. Vents often were installed to improve the breathability of aerogel daily clothing, but a few consumers said that the clothing microclimates were not well controlled through vents.

From the results of market research, the development of aerogel daily clothing is becoming active and specialized. But there are still many difficulties in development due to lack of experience. One problem is that the covering area and position of aerogel composite is similar in the current aerogel daily clothing. Therefore, it is necessary to study the influence on the property of aerogel daily clothing when changing the covering area and position of the aerogel composite, and based on this, to develop the appropriate aerogel daily clothing for the different wearing conditions. Another problem is that the analysis of consumer reviews only provides a rough understanding of the property of aerogel daily clothing. It is difficult to analyze the results more specifically because each consumer's wearing experience and wearing environment are different, and no

uniform rating scale is provided for consumers. If the standard scientific analysis has been added through physical evaluation, we will be understood the performance of aerogel daily clothing in more detail. In particular, the relationship between the application method of aerogel composite and the warmth property of aerogel daily clothing should be further clarified through scientific evaluation.

The results can provide specific and diverse reference data for the development of aerogel daily clothing in the future. If more objective and detailed research is conducted, we expected that the performance of the aerogel daily clothing will improve and the utilization of the aerogel composite in the daily clothing field will increase.

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