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**3D network structured fiber
materials of the thermoplastic
polymer**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Act.

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NOTE Based on Article 9 of the Supplementary Provisions to the Unfair Competition Prevention Act etc., procedures such as deliberation by the Japanese Industrial Standards Committee employed under the previous Industrial Standardization Act shall be deemed to have been conducted pursuant to the revised Industrial Standardization Act.

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3D network structured fiber materials of the thermoplastic polymer

1 Scope

This Japanese Industrial Standard specifies requirements for the fiber structures comprising a spacial structure obtained by welding or connecting of continuous fibers of thermoplastic resin in three dimensional directions (hereafter referred to as thermoplastic 3D network fiber structures).

This Standard is applicable to thermoplastic 3D network fiber structures used for the cushioning of load-bearing products such as bedding items, chairs, seats of moving bodies, etc.

The classification of thermoplastic 3D network fiber structures by product type is shown in Table 1.

This Standard is not applicable to:

- a) single layer products 5 mm or less in thickness ¹⁾ and laminated products 5 mm or less in thickness;
- b) raised fibers or pile fibers used for hook-and-loop fasteners, floor coverings, etc.;
- c) multiaxial woven fabrics such as triaxial woven fabric and quadraxial woven fabric;
- d) thermoplastic 3D network fiber structures used for construction materials;
- e) laminated products consisting of thermoplastic 3D network fiber structures and other materials.

Note ¹⁾ For these products, the test piece specified in Annex B may be used to determine characteristic values of test piece according to the methods given in Clause 9, in which case, however, the classifications specified in Clause 4 cannot be applied.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7512 *Steel tape measures*

JIS B 7516 *Metal rules*

JIS K 6418 *Thermoplastic elastomers—Nomenclature and abbreviated terms*

JIS K 6899-1 *Plastics—Symbols and abbreviated terms—Part 1: Basic polymers and their special characteristics*

JIS K 7248 *Cellular plastics and rubbers—Determination of linear dimensions*

JIS L 0105 *General principles of physical testing methods for textiles*

JIS L 0204-2 *Glossary of terms used in fibre—Part 2: Man-made fibres*

JIS L 0205 *Glossary of terms used in yarn*

- JIS L 0206 *Glossary of terms used in textile industry (woven fabrics)*
JIS L 0208 *Glossary of terms used in textile industry—Testing*
JIS L 0211 *Glossary of terms used in textile industry—Knitting section*
JIS Z 8401 *Rounding of numbers*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS K 6418**, **JIS K 6899-1**, **JIS L 0105**, **JIS L 0204-2**, **JIS L 0205**, **JIS L 0206**, **JIS L 0208** and **JIS L 0211**, and the following apply.

3.1

thermoplastic 3D network fiber structure

fiber structure comprising a spacial structure obtained by welding or connecting of continuous fibers of thermoplastic resin in three dimensional directions

This structure is classified into the following three types.

- a) **3D random loop network structure** fiber structure comprising a spatial structure obtained by welding random loops of continuous fibers of thermoplastic resin through making them mutually contact in a molten state in three dimensional directions
- b) **3D solid knit** fiber structure comprising a three-dimensional structure obtained by making continuous fibers of thermoplastic resin connect two or more independent knitted texture layers comprised of continuous fibers of thermoplastic resin
- c) **3D solid textile** fiber structure comprising a three-dimensional structure obtained by making two or more independent knitted texture layers comprised of continuous fibers of thermoplastic resin connected with continuous fibers of thermoplastic resin

3.2

length

distance from tip to end of one axis existing on the surface subjected to load, in the following directions:

- a) longitudinal direction of fibers in the case of 3D random loop network structure;
- b) direction of wale in the case of 3D solid knit;
- c) direction of warp in the case of 3D solid textile.

3.3

width

distance from tip to end of an axis existing on the surface subjected to load, in a direction perpendicular to the longitudinal axis

3.4

thickness

distance from the upper surface to the lower surface in a direction perpendicular to the surface subjected to load

It is the distance from the upper surface of the uppermost layer to the lower surface of the lowermost layer in the case of a laminated product.

3.5

apparent density

mass per unit volume

NOTE The apparent density is expressed by kilogrammes per cubic metre (kg/m^3).

3.6

basis weight

mass per unit area

NOTE The basis weight is expressed by grammes per square metre (g/m^2).

3.7

hardness

force, applied at a constant speed, required to compress a thermoplastic 3D network fiber structure in the thickness direction to a predetermined compressibility ratio

3.8

compressive deflection coefficient

force at compression of a thermoplastic 3D network fiber structure in the thickness direction to 65 % of its initial thickness divided by the force at compression to 25 % of its initial thickness

3.9

hysteresis loss rate

rate of loss of mechanical energy in one cycle of deformation and recovery

3.10

modulus of repulsion elasticity

when a specified weight is dropped from a specified height on a thermoplastic 3D network fiber structure, the value of maximum rebound height divided by the drop height

3.11

repeated compression residual strain

rate of decrease in thickness of a thermoplastic 3D network fiber structure occurring when it is repeatedly compressed in the thickness direction to 50 % of its thickness in an environment at a given temperature

3.12

repeated compression hardness decrease rate

rate of decrease in hardness of a thermoplastic 3D network fiber structure occurring when it is repeatedly compressed in the thickness direction to 50 % of its thickness in an environment at a given temperature

3.13

dry heat compression residual strain

rate of decrease in thickness of a thermoplastic 3D network fiber structure occurring when it has been maintained under a specified deformation for a given period of time at a given temperature and then released

3.14

air flow rate

volume of air flow that vertically passes through a test piece under the conditions of the specified area, differential pressure and duration

4 Classification and grades

4.1 Classification by product type

The thermoplastic 3D network fiber structures are classified by product type as given in Table 1.

Table 1 Classification by product type

Classification	Symbol	Product type
Single layer product	S	Comprised of one layer of thermoplastic 3D network fiber structure
Laminated product ^{a)}	P	Comprised of multiple laminated layers of thermoplastic 3D network fiber structure
Note ^{a)} Includes laminated products produced by fixing single layer products together by sewing, tying, bonding, heat-sealing, or other means to keep them from being separated.		

4.2 Classification by fiber used

The thermoplastic 3D network fiber structures are classified by fiber used as given in Table 2.

If the thermoplastic 3D network fiber structure is comprised of two or more types of fiber, it shall be classified by the fiber that is the largest component.

Table 2 Classification by fiber used

Type of fiber	Symbol
Nylon fiber	NY
Polyester fiber	ES
Polyethylene fiber	PE
Polypropylene fiber	PP
Amide-based thermoplastic elastomer fiber	TPA
Ester-based thermoplastic elastomer fiber	TPC
Olefin-based thermoplastic elastomer fiber	TPO
Styrene-based thermoplastic elastomer fiber	TPS
Urethane-based thermoplastic elastomer fiber	TPU
Ethylene-vinyl acetate copolymer fiber	EVAC
Other fiber	TPZ

4.3 Classification by modulus of repulsion elasticity

The thermoplastic 3D network fiber structures are classified by modulus of repulsion elasticity as given in Table 3.

Table 3 Classification by modulus of repulsion elasticity

Grade	Symbol
High repulsion	H
Medium repulsion	M
Low repulsion	L

4.4 Classification by durability

The thermoplastic 3D network fiber structures are classified by durability as given in Table 4.

Table 4 Classification by durability

Grade	Symbol
1	D1
2	D2
3	D3

5 Quality

5.1 Tolerances on apparent density and basis weight

The apparent density of a thermoplastic 3D network fiber structure shall be expressed by a nominal value. The result of the test performed according to **9.3** shall not deviate from the nominal value by more than $\pm 10 \%$.

For thermoplastic 3D network fiber structures less than 15 mm thick or having an indefinite shape that is not cuboid (hereafter referred to as indefinite shape products), for which performing an apparent density test is difficult, the nominal value of basis weight may instead be indicated, in which case the permitted deviation of the test result obtained according to **9.3** is also $\pm 10 \%$.

5.2 Modulus of repulsion elasticity

The modulus of repulsion elasticity of a thermoplastic 3D network fiber structure shall be classified by the modulus of repulsion elasticity, and when tested according to **9.5**, shall conform to the requirements in Table 5.

Table 5 Modulus of repulsion elasticity

Unit: %

Grade	Symbol	Modulus of repulsion elasticity
High repulsion	H	50.0 or over
Medium repulsion	M	15.0 or over to and excl. 50.0
Low repulsion	L	Under 15.0

5.3 Durability

The durability of a thermoplastic 3D network fiber structure shall be classified by repeated compression hardness decrease rate, repeated compression residual strain and dry heat compression residual strain, and when tested according to **9.6** and **9.7**, shall conform to the requirements in Table 6.

For durability classification, all three of the above-mentioned requirements shall be satisfied. A product shall be assigned the lowest grade among the grades corresponding to the three requirements satisfied by that product.

Example A product of which the repeated compression hardness decrease rate is 15 %, repeated compression residual strain is 8 %, and dry heat compression residual strain is 30 % is assigned Grade 2.

Table 6 Durability

Unit: %

Grade	Symbol	Repeated compression hardness decrease rate	Repeated compression residual strain	Dry heat compression residual strain
1	D1	20.0 or under	15 or under	20.0 or under
2	D2	Over 20.0 up to and incl. 30.0		Over 20.0 up to and incl. 40.0
3	D3	Over 30.0 up to and incl. 40.0		Over 40.0 up to and incl. 60.0

5.4 Air flow rate

The air flow rate of a thermoplastic 3D network fiber structure, when tested according to **9.8**, shall not be less than $400 \text{ cm}^3/\text{cm}^2 \cdot \text{s}$.