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BUREAU OF INDIAN STANDARDS

AGENDA

3rd Meeting of Panel (TXD 40/P01) under TXD 40 to discuss and deliberate on different types of carbon fibres

Date/Day	Time	Venue
31 May 2024	16 : 00	Through Video Conferencing

CONVENER: Dr. Hemant Kumar Shukla
(NAL, Bangalore)

MEMBER SECRETARY: Shri Swapnil, Scientist-B/Asst. Director, BIS

Item 0 WELCOME AND INTRODUCTORY REMARKS BY THE CONVENER

Item 1 CONFIRMATION OF THE MINUTES OF THE PREVIOUS MEETING

1.1 The minutes of the second panel meeting held on 23 June 2023 through CISCO Webex videoconferencing were circulated vide email dated 24 June 2023. No Comment has been received.

1.1.1 The Panel may **CONFIRM** the minutes.

Item 2 COMPOSITION OF PANEL

2.1 The present composition of the panel is given as follows:

i) Dr. Hemant Kumar Shukla (Convener)
NAL, Bangalore
ii) Mrs. Sheeja Sunil Member
NAL, Bangalore
iii) Dr. Dhaval Patel Member
Nikol Advance Materials Pvt Ltd, Ahmedabad
iv) Dr. Milind Khandwe Member
Bhor Chemicals and Plastics Pvt Ltd, Mumbai
v) Dr. Ravi Sriraman Member
Avient Corporation, Shirur
vi) Reliance Industries Ltd
vii) Shri Swapnil Member Secretary
BIS, New Delhi

2.1.1 The panel may **NOTE**.

Item 3 NEW SUBJECTS

3.1 In the 6th of TXD 40, the committee decided to convene a panel meeting again to discuss/prepare the preliminary draft covering the different types/grades of carbon fibres prevalent in market/industries.

3.2 In the last panel meeting, the panel decided as follows:

a) Mrs. Sheeja Sunil, NAL, Bangalore shall provide the following inputs/ modifications related to working/preliminary draft on 'Textiles – Carbon Fibres – Specification'as per **item 3 (a)** to the minutes of 2nd panel meeting.

Based on the inputs received from Mrs. Sheeja Sunil, NAL Bangalore and other stakeholders, working draft on 'Textiles – Carbon Fibres – Specification' has been prepared and given in **Annex 1 (Pages 3-7)**.

b) Dr. Dhaval Patel, Nikol Advance Materials Pvt Ltd, Ahmedabad shall provide the list of users of Carbon fibres.

No inputs have been received.

c) Dr. Milind Khandwe, Bhor Chemicals and Plastics Pvt Ltd, Mumbai shall provide the inputs related to additional characteristics such as spool hardness, electrical conductivity, functional group on fibre surface etc. of Carbon fibres along with their test methods.

Inputs related to definition of additional characteristics have been received.

d) BIS shall share the working/preliminary draft on 'Textiles – Carbon fibres - Specification' as placed before the panel during the meeting for comments/ inputs/ suggestions from convenor and all other members.

No comments/ inputs/ suggestions have been received.

3.2.1 The Panel may **DELIBERATE** and **DECIDE**.

Item 4 ANY OTHER BUSINESS

ANNEX 1

(*Item* 3.2)

WORKING DRAFT ON 'TEXTILES – CARBON FIBRES – SPECIFICATION'

FOREWORD

Carbon fibre is a material consisting of thin, strong crystalline filaments of carbon, essentially carbon atoms bonded together in long chains. Carbon fibres are produced by controlled oxidation and carbonization of organic precursor fibres. The organic precursor fibre used for manufacture of carbon fibre, is generally a special textile polymeric fibre that can be carbonized without melting.

The fibres are extremely stiff, strong, and light, and are used in many processes to create excellent structural materials thus Carbon fibres are essential for various industries such as wind energy, infrastructure, sports and transportation.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (second revision)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

This standard specifies requirements for Pitch based and PAN based Carbon fibre for various end usages.

2 REFERENCES

The standards listed in Annex A contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMS AND DEFINITIONS

3.1 Precursor

Raw material for carbon fiber. In case of PAN-based carbon fibers, polyacrylonitrile fiber is the precursor. Pitch-based carbon fibers use petroleum or coal tar-based precursors.

3.2 Oxidation (Stabilization)

The thermal process whereby the precursor is converted into a cross-linked, thermoset material that is capable of maintaining its shape during the carbonization process.

3.3 Carbonization

The thermal process whereby stabilized (oxidized) PAN or pitch fibers are heated to a temperature of 1200 °C to 1500 °C, in order to develop the ultimate strength and modulus of the fibers.

3.4 Graphitization

The process of heat treating carbonized precursor fiber in an inert atmosphere, such as nitrogen, at temperatures of 2000 °C to 3000 °C. This process produces carbon fibres with fine graphite crystalline structures and a range of high modulus and strength properties.

3.5 PAN

The acronym for polyacrylonitrile, the raw material (precursor) for the most common type of carbon fibers. PAN-based carbon fibers are especially suited for use in structural applications due to their high tensile and compressive strengths relative to pitch-based carbon fibers.

3.6 Surface Treatment

The electrochemical treatment which partially oxidizes the fiber surface, creating chemically active sites that promote adhesion to a resin matrix. Different surface treatment processes may be employed to impart differing fiber surface characteristics, as desired.

3.7 Tow (Roving, Strand)

A large grouping of carbon fiber filaments packaged together onto a single spool, or bobbin. Also referred to as a roving or strand. The term “small tow” refers to carbon fiber rovings that contain 24,000 (24K) or fewer filaments. “Large tow” refers to carbon fiber rovings that contain on the order of 48,000 to 320,000 (48K – 320K) filaments or more.

3.8 Yield

A measure of a rovings linear density, expressed as the weight of fiber per unit length. When expressed as grams per 1000 meters, the yield is equal to the “TEX.”

3.9 Axial

Reference made to a characteristic in the direction of the fiber orientation.

3.10 Transverse

Reference made to a characteristic in a direction 90° to the fiber orientation.

3.11 Unidirectional (UD) Sheet or Tape (Unitape)

A roll of carbon fiber prepreg with its fiber arranged in parallel and impregnated by matrix. Prepreg using this is called UD (unidirectional) prepreg or unitape, which offers high fiber content, low aerial weight, and maximum mechanical features in the direction of fiber.

3.12 TEX

A measure of the weight of fiber per unit length, expressed as grams per 1000 meters of roving or yarn. The lower the TEX, the finer the roving. More generally referred to as yield.

3.13 Denier

A direct numbering system for measuring fiber linear density (yield), equal to the mass in grams per 9000 meters of fiber roving.

3.14 Elongation

The increase in length of a material during a tensile test, usually expressed as a percentage of the original length.

3.15 Modulus

The change in stress divided by the change in strain of a loaded material specimen within its elastic (non-yielded) range. A measure of a material's stiffness.

3.16 Sizing

A polymeric coating added to carbon fibers in order to improve handling and processing. Sizing can also improve compatibility between reinforcing fibers and matrix resin systems.

3.17 Specific Modulus

Modulus divided by weight per unit volume.

3.18 Specific Strength

Strength divided by weight per unit volume.

3.19 Bobbin (Spool)

The individual package in which a carbon fiber roving is wound onto a core.

4 TYPES

Carbon fibre shall be classified in following two types based on precursor used:

a) *Type* I — Carbon fibre manufacture by using polyacrylonitrile as precursor material.
b) *Type* II — Carbon fibre manufacture by using pitch as precursor material.

5 REQUIREMENTS

Carbon fibre shall meet the requirements as specified in Table 1.

Table 1 Requirements of Carbon fibre based on Precursor type
(*Clause* 5)

Sl No.	Characteristic	Requirement		Method of Test, Ref to
		Type I	Type II	
(1)	(2)	(3)	(4)	(5)
i)	Tensile strength, MPa	1800 - 6400	1300 - 4000	IS 17311
ii)	Tensile modulus, GPa	160 - 600	55 - 900	IS 17311
iii)	Density, gm/cm^3	1.7 - 1.9	2 - 2.2	IS 17306
iv)	Elongation at Break, percent	1.3 - 1.7	0.6 - 0.8	IS 17311
v)	Carbon content, percent	92 - 96	98 - 99	Annex B
vi)	Weight/Length, g/m	0.21 - 2.94	0.31 - 3.42	IS 17298
vii)	Sizing content, percent	0.8 - 1.6	0.8 - 1.6	IS 17605
viii)	Filament diameter, µm	5 - 12	8 - 18	IS 17307

6 PACKING

6.1 Carbon fibers shall supply in spools of 1K, 3K, 6K, 12K, 24K or 48K tows such that the contents are safe from weather, dirt, dust and water, etc.

6.2 Spools shall be packed in cases/cartons strong enough to withstand normal hazards of storage and transport. Details of the packing shall be as agreed to between the buyer and the seller.

6.3 Each case/carton shall also bear the following information:

a) Manufacturer Name and Address;

b) Carbon Fibre Manufacturing Plant Address and Manufacturing Line(s);

c) Carbon Fibre Distributor Name and Address (if different from manufacturer);

d) Product Designation; and

e) MSDS (Material Safety Data Sheet).

7 MARKING

7.1 Each tow of carbon fibres shall be marked with an indelible ink the following information:

a) Complete description of carbon fibre by:
   i) Type;
   ii) Net mass of each package, that is, spool with Sl No.;
   iii)Lot/batch No.; and
b) Any other information required by the law in force.

7.2 Instructions for transportation, handling and storage of Carbon fibres shall also be provided by the manufacturer along with each consignment for proper care.

7.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

8 SAMPLING

8.1 The number of spools of the same type delivered to a buyer against one dispatch note shall constitute a lot.

8.2 The number of samples and the size of the specimens presented to the different test methods, shall be in accordance with the respective test standards specified in the requirements of Clause **5**.

ANNEX A
(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 17298 : 2019	Reinforcement yarns — Determination of linear density
IS 17306 : 2019	Carbon fibre — Determination of density
IS 17307 : 2019	Carbon fibre — Determination of filament diameter and cross-sectional area
IS 17311 : 2019	Carbon fibre — Determination of the tensile properties of single-filament specimens
IS 17605 : 2021	Carbon fibre Determination of size content

ANNEX B
[*Clause* 5 and *Table* 1, *Sl No.* (v)]

DETERMINATION OF CARBON CONTENT

B-1 PROCEDURE

B-1.1 Elemental analysis

Elemental analyzers are extremely useful and provide a rapid determination (under 5 min) of C, H and N using He or Ar as a carrier gas. The sample is placed in a Sn capsule and first oxidized in a pure O_2 environment in the presence of reagents and a platinized carbon catalyst. The resulting combustion gases (CO_2, H_2O and N_2) are then scrubbed using a heated Cu tube to remove any sulphur products from the oxidation and NaOH to remove acid gases. The carrier gas sweeps the product gases into a chamber where they are mixed and controlled to exact conditions of pressure, temperature and volume. The homogenized product gases are then depressurized, passed through a column and separated under steady state conditions using a technique called frontal chromatography, which utilizes the selective retention of the gases to produce a steady state stepwise signal. The stepwise series of gases then pass through a thermal conductivity detector system and are measured. Versions are available for the additional determination of sulphur (CHNS) and an oxygen kit can also be provided. The analysis of carbon fiber shall be reported.