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Plastics — Determination of electrical properties of thin sheet and film

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

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It has been approved by the Member Bodies of the following countries :

Australia	Hungary	South Africa, Rep. of
Austria	India	Spain
Belgium	Ireland	Sweden
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Czechoslovakia	Japan	United Kingdom
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France	New Zealand	U.S.S.R.
Germany	Poland	Yugoslavia
Greece	Portugal	

No Member Body expressed disapproval of the document.

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Plastics — Determination of electrical properties of thin sheet and film

0 INTRODUCTION

This International Standard is intended to specify methods of determining specific electrical properties of thin plastics sheet and film in accordance with procedures specified by the International Electrotechnical Commission (IEC). Some variation in test results can occur due to certain factors which are brought to the attention of the users of this International Standard in the form of "precautionary notes". These methods are applicable to all plastics sheet and film (excluding laminated sheets). However, for sheets and films made from materials sensitive to moisture, selective conditioning may be required.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies methods for the determination of the following electrical properties of thin plastics sheet or film of thickness not greater than 0,5 mm (excluding laminated sheets) :

a) electric strength;

b) permittivity and dielectric dissipation factor;

c) volume resistivity.

2 REFERENCES

ISO/R 291, *Standard atmospheres for conditioning and testing.*

IEC Publication 243, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

IEC Publication 250, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.*

IEC Publication 93, *Recommended methods of test for volume and surface resistivities of electrical insulating materials.*

IEC Draft Publication 15 C (Central Office) 33, *Specification for pressure sensitive adhesive tapes for electrical purposes. Part 2 : Methods of test.*

3 DETERMINATION OF ELECTRIC STRENGTH

3.1 Principle

The electric strength of thin sheet and film shall be determined in accordance with the relevant parts of IEC Publication 243 and, additionally, in accordance with the following requirements.

3.2 Measurement of thickness

The thickness of the specimen shall be measured in accordance with the relevant part of IEC Publication . . .[1)]

3.3 Test specimen

The test specimen shall consist of a single thickness of sheet or film. Its surfaces must be clean and must not be touched with the hands or contaminated before the test.

PRECAUTIONARY NOTE – The use of two or more thicknesses of sheet or film to minimize the effect of weak spots is not recommended, as this may affect the result.

3.4 Conditioning

The specimen shall be preconditioned for 96 h in one of the standard atmospheres defined in ISO/R 291, for preference at a temperature of 23 °C and a relative humidity of 50 %. For materials which are sensitive to moisture, condition the specimen in accordance with the relevant material specification or as agreed upon between consumer and supplier. The specimens shall be tested immediately after conditioning.

3.5 Electrodes

The electrodes shall consist of two brass rods, 6 mm in diameter, mounted coaxially, one above the other, in a jig. The specimen is held between the ends of the rods. These ends shall be squared, their edges having a radius of about 1 mm. The mass of the rod forming the upper electrode shall be 50 ± 2 g.

PRECAUTIONARY NOTE – In the case where the given electrodes are not used, electrodes of greater diameter can be expected to give lower values of dielectric strength because of the larger area of thin sheet or film that will be covered by the electrodes and the consequent increase in probability that a lower thickness or a weak spot will be included.

1) At present IEC Draft Publication 15 C (Central Office) 33.

3.6 Test conditions

The specimen shall be tested at the temperature of conditioning (see 3.4) in one of the following environments :

a) standard atmosphere (see 3.4);

b) transformer oil with a permittivity ϵ_r of about 2,2;

c) any other insulating liquid with a known permittivity.

PRECAUTIONARY NOTE — When the test is carried out in air, the result may be lower than results obtained in other environments. When the test is carried out in oil or other liquids, it should be completed within a period of 1 min to avoid possible attack of the specimen by the oil or liquid. Moreover, in such tests care must be taken to avoid the presence of bubbles around the edges of the electrodes.

3.7 Rate of increase in voltage

The rate of increase in voltage shall be in accordance with clause 7.1 of IEC Publication 243.

3.8 Number of tests

Unless otherwise specified, the number of tests shall be

30 for sheet or film of thickness less than 0,02 mm;

20 for sheet or film of thickness 0,02 to 0,05 mm;

10 for sheet or film of thickness greater than 0,05 mm.

The electric strength is determined by calculating the average of the results. For every test result which deviates by more than 10 % from the average, an additional test shall be made, the electric strength being then determined from the average of all the results;

3.9 Test report

The test report shall include the following information :

a) description of the material tested;

b) the electric strength in megavolts per metre (MV/m) as the average of all the results :

c) the number of tests;

d) the mean thickness of the material;

e) the test conditions, i.e. frequency, type of electrodes, characteristics of test environment (including permittivity), method of application of the voltage and, when applicable, the humidity.

4 DETERMINATION OF PERMITTIVITY AND DIELECTRIC DISSIPATION FACTOR

4.1 Principle

The permittivity and dielectric dissipation factor of thin sheet and film shall be determined in accordance with the relevant parts of IEC Publication 250 and, additionally, in accordance with the following requirements.

1) At present IEC Draft Publication 15 C (Central Office) 33.

4.2 Measurement of thickness

The thickness of the specimen shall be measured within the electrode test area in accordance with the relevant parts of IEC Publication . . .[1)]

The mean value of ten measurements shall be used in the calculation of the permittivity and dielectric dissipation factor of the specimen.

4.3 Test specimen

The surfaces of the test specimen must be clean and must not be touched with the hands or contaminated before the test.

4.4 Conditioning

The specimen shall be preconditioned for 24 h in one of the standard atmospheres defined in ISO/R 291, for preference at a temperature of 23 °C and a relative humidity of 50 %, before and after the application of the electrodes. For materials which are sensitive to moisture, condition the specimen in accordance with the relevant material specification or as agreed upon between consumer and supplier.

4.5 Electrodes

Unless otherwise specified in the method, the electrodes shall be applied in the standard conditions given in 4.4.

The electrodes shall be one of the following types :

a) metal applied by cathodic evaporation or by evaporation in high vacuum;

b) high conductivity silver paint applied by spraying and drying in the conditioning atmosphere;

c) pressed metal foil electrodes applied in the conditioning atmosphere with a minimum quantity of suitable grease or oil in such a manner that the inclusion of air between the electrode and the specimen is prevented.

The electrodes shall be in the form of two discs, one 25 mm in diameter and the other 40 mm in diameter. The discs shall be coaxially positioned on opposite faces of the test specimen. A guard ring may be used around the small electrode in order to reduce losses due to superficial conductivity.

PRECAUTIONARY NOTES

1 Type a) electrodes shall not be used on materials which lose volatile matter under the conditions of application. Silver electrodes shall not be used for tests conducted over long time periods when corrosion, oxidation or chemical activity of the electrode may occur.

2 Type b) electrodes shall not be used on materials which are attacked or affected by the solvent in the paint. This solvent must be completely evaporated before the specimen is tested.

4.6 Test frequencies and test voltage

The frequency of the test voltage shall be 50 (or 60) Hz, 1 kHz or 1 MHz. The voltage shall be 1 V for each micrometre of film thickness, with a maximum of 30 V. The measurement shall be made within 1 min of the application of the test voltage.

4.7 Number of tests

Unless otherwise specified, three specimens shall be tested and the permittivity and dielectric dissipation factor determined by calculating the average of the three test results.

4.8 Test report

The test report shall include the following information :

a) description of the material tested;

b) the permittivity and/or the dielectric dissipation factor for each test;

c) the mean thickness of the material (see 4.2);

d) the applied voltage and its frequency and duration (see 4.6);

e) the type of electrode (see 4.5);

f) the number of tests;

g) the method of conditioning the test specimens (see 4.4).

5 DETERMINATION OF VOLUME RESISTIVITY

5.1 Principle

The volume resistivity of thin sheet or film shall be determined in accordance with the relevant parts of IEC Publication 93 and, additionally, in accordance with the following requirements.

5.2 Measurement of thickness

The thickness of the specimen shall be measured within the electrode test area in accordance with the relevant parts of IEC Publication . . .[1)]

The mean value of five measurements shall be used in the calculation of the volume resistivity of the test specimen.

5.3 Test specimen

The surfaces of the test specimen must be clean and must not be touched with the hands or contaminated before the test.

5.4 Conditioning

The specimen shall be preconditioned under the same conditions as those specified for the determination of permittivity and dielectric dissipation factor (see 4.4).

5.5 Electrodes

Unless otherwise specified in the method, the electrodes shall be applied under the standard conditions given in 4.4.

The electrodes shall be one of the same types, and of the same size, form and position, as specified for the determination of permittivity and dielectric dissipation factor (see 4,5) except that a guard ring shall be used around the small electrode.

5.6 Test voltage

Tests shall be made at the following steady voltages :

100 V d.c. for thin sheet or film of thickness greater than 0,1 mm;

10 V d.c. for thin sheet or film of thickness 0,1 to 0,01 mm;

1 V d.c. for thin sheet or film of thickness less than 0,01 mm.

Make the measurements after the test voltage has been applied to the specimen for 1 min.

5.7 Test report

The test report shall include the following information :

a) description of the material tested;

b) the volume resistivity in ohm centimetres (Ω.cm);

c) the mean thickness of the material (see 5.2);

d) the applied voltage (see 5.6);

e) the type of electrode (see 5.5);

f) the method of conditioning the test specimens (see 5.4).

1) At present IEC Draft Publication 15 C (Central Office) 33.