

# Dielectric Strength

Dielectric Strength reflects the **electric strength of insulating materials** at various power frequencies. Or it can be defined as the measure of dielectric breakdown resistance of a material under an applied voltage and is expressed as Volts per unit thickness. It is an indicator of how good an insulator a material is.

In other words, it is the **voltage per unit thickness** at which a material will conduct electricity. The higher the value, the more electrically insulating a material is.

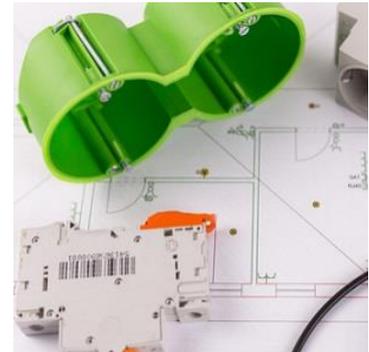
It is an important property sought for materials used in applications where electrical field is present and is a vital parameter for electrical industry applications.

## Applications include:

- » Development of materials for energy storage applications
- » Dielectric materials for capacitors
- » Thin films in high speed digital circuitry

The dielectric strength depends on:

- » The type of the plastic and electrodes
- » The shape of the plastic and electrodes
- » The rate with which the field is increased, and
- » The medium that surrounds the insulator



**Unit for Dielectric Strength** is kV by mm of thickness (customary units sometimes refer to in V/mil).

## *Check out more on Dielectric Strength:*

- » **Dielectric Strength Values of Several Plastics**
- » **How to Calculate the Dielectric Strength of Plastic**
- » **Factors Affecting Dielectric Strength**

## **How to Measure Dielectric Strength?**

The most generally used standard tests to calculate dielectric strength are ASTM D149 or IEC 60243-1 (*ofcourse there exist several other methods as well, but they*

*are not discussed here).*

The measurement of dielectric strength is usually carried out either by the:

- » Short-time method
- » Slow rate-of-rise method
- » Step-by-Step method

### **Short-time method**

In this method, the voltage is applied across the two electrodes and increased continuously at a uniform rate (500 V/sec) until the breakdown occurs. Breakdown is defined as when an electrical burn- through punctures the sample or decomposition occurs in the sample.

### **Slow rate-of-rise method**

In this test method, the voltage is applied to the test electrodes from the starting voltage 50% of the breakdown voltage until breakdown occurs.

### **Step-by-Step method**

The voltage is applied to the test electrodes at the preferred starting voltage in steps and duration until breakdown occurs.

**Specimen Size** - The recommended specimen type is a 4 inch plaque or larger. Any specimen thickness can be used.

Dielectric strength is calculated by dividing the breakdown voltage by the thickness of the sample.

Most plastics have good dielectric strengths (in the order of 100 to 300 kV/cm).

### **Factors Affecting Dielectric Strength**

- **The dielectric strength of an insulation material usually decreases with increase in temperature**

It is approximately inversely proportional to the absolute temperature. At the same time, it is equally important to note that below room temperature, dielectric strength is substantially independent of temperature change.

- **Mechanical loading has a pronounced effect on dielectric strength**

Since, a mechanical stress may introduce internal flaws which serve as leakage paths, mechanical loaded insulators may show substantially reduced values of dielectric strength.

- **Dielectric Strength of an insulating material is influenced by the fabrication details**

For example, flow lines in a compression molding or weld lines in an injection molding may serve as paths of least resistance of leakage currents, this reducing the dielectric strength. Even nearly invisible minute flaws in a plastics insulator may reduce the dielectric strength to one-third this normal value.

### Dielectric Strength Values of Several Plastics

Polymer Name	Min Value (kV/mm)	Max Value (kV/mm)
ABS - Acrylonitrile Butadiene Styrene	15.70	34.00
ABS Flame Retardant	24.00	35.40
ABS High Heat	12.00	20.00
ABS High Impact	12.00	20.00
ABS/PC Blend - Acrylonitrile Butadiene Styrene/Polycarbonate Blend	15.00	70.00
ABS/PC Blend 20% Glass Fiber	29.90	30.00
Amorphous TPI Blend, Ultra-high heat, Chemical Resistant (Standard Flow)	54.00	54.00
Amorphous TPI, Moderate Heat, Transparent	17.00	17.00
Amorphous TPI, Moderate Heat, Transparent (Food Contact Approved)	17.00	17.00
Amorphous TPI, Moderate Heat, Transparent (Mold Release grade)	14.00	14.00
Amorphous TPI, Moderate Heat, Transparent (Powder form)	17.00	17.00

ASA - Acrylonitrile Styrene Acrylate	40.00	105.00
ASA/PC Blend - Acrylonitrile Styrene Acrylate/Polycarbonate Blend	80.00	95.00
ASA/PC Flame Retardant	90.00	90.00
CA - Cellulose Acetate	8.00	15.00
CAB - Cellulose Acetate Butyrate	10.00	16.00
CP - Cellulose Propionate	12.00	18.00
CPVC - Chlorinated Polyvinyl Chloride	50.00	60.00
ECTFE - Ethylene ChloroTriFluoroEthylene	14.00	14.00
ETFE - Ethylene Tetrafluoroethylene	7.870	7.870
EVA - Ethylene Vinyl Acetate	27.00	28.00
FEP - Fluorinated Ethylene Propylene	22.00	79.00
HDPE - High Density Polyethylene	17.00	24.00
HIPS - High Impact Polystyrene	12.00	24.00
HIPS Flame Retardant V0	33.00	35.00
Ionomer (Ethylene-Methyl Acrylate Copolymer)	40.00	40.00
LCP - Liquid Crystal Polymer	32.00	39.00
LCP Glass Fiber-reinforced	22.00	30.00
LCP Mineral-filled	26.00	35.00
LDPE - Low Density Polyethylene	16.00	28.00
MABS - Transparent Acrylonitrile Butadiene Styrene	34.00	37.00
PA 11 - (Polyamide 11) 30% Glass fiber reinforced	40.00	40.00
PA 11, Conductive	24.00	55.00
PA 11, Flexible	24.00	55.00

PA 11, Rigid	24.00	55.00
PA 12 (Polyamide 12), Conductive	24.00	55.00
PA 12, Fiber-reinforced	24.00	55.00
PA 12, Flexible	24.00	55.00
PA 12, Glass Filled	24.00	55.00
PA 12, Rigid	24.00	55.00
PA 46 - Polyamide 46	15.00	25.00
PA 46, 30% Glass Fiber	25.00	35.00
PA 6 - Polyamide 6	10.00	20.00
PA 6-10 - Polyamide 6-10	16.00	26.00
PA 66 - Polyamide 6-6	20.00	30.00
PA 66, 30% Glass Fiber	25.00	25.00
PA 66, 30% Mineral filled	25.00	30.00
PA 66, Impact Modified, 15-30% Glass Fiber	11.80	21.00
PA 66, Impact Modified	18.00	90.00
PA 66, Carbon Fiber, Long, 30% Filler by Weight	1.300	1.300
PAI - Polyamide-Imide	23.60	24.00
PAI, 30% Glass Fiber	27.60	34.00
PAR - Polyarylate	17.00	17.00
PARA (Polyarylamide), 30-60% glass fiber	23.70	30.00
PBT - Polybutylene Terephthalate	15.00	30.00
PBT, 30% Glass Fiber	50.00	50.00
PC (Polycarbonate) 20-40% Glass Fiber	20.00	20.00
PC (Polycarbonate) 20-40% Glass Fiber	17.00	38.00

Flame Retardant		
PC - Polycarbonate, high heat	16.00	35.00
PCTFE - Polymonochlorotrifluoroethylene	21.00	24.00
PE - Polyethylene 30% Glass Fiber	19.70	19.70
PEEK - Polyetheretherketone	20.00	20.00
PEEK 30% Carbon Fiber-reinforced	18.50	19.00
PEEK 30% Glass Fiber-reinforced	15.00	24.00
PEI - Polyetherimide	28.00	33.00
PEI, 30% Glass Fiber-reinforced	25.00	30.00
PEI, Mineral Filled	20.00	25.00
PEKK (Polyetherketoneketone), Low Cristallinity Grade	23.60	23.60
PESU - Polyethersulfone	16.00	80.00
PESU 10-30% glass fiber	14.60	40.00
PET - Polyethylene Terephthalate	60.00	60.00
PET, 30% Glass Fiber-reinforced	16.80	22.50
PETG - Polyethylene Terephthalate Glycol	45.00	45.00
PFA - Perfluoroalkoxy	2.100	2.200
PGA - Polyglycolides	34.00	80.00
PI - Polyimide	22.00	27.60
PMMA - Polymethylmethacrylate/Acrylic	15.00	22.00
PMMA (Acrylic) High Heat	18.70	20.00
PMMA (Acrylic) Impact Modified	15.00	60.00
PMP - Polymethylpentene	28.00	30.00
PMP 30% Glass Fiber-reinforced	23.60	23.60

PMP Mineral Filled	23.60	23.60
POM - Polyoxymethylene (Acetal)	13.80	20.00
POM (Acetal) Impact Modified	19.00	19.00
POM (Acetal) Low Friction	16.00	16.00
PP - Polypropylene 10-20% Glass Fiber	30.00	45.00
PP, 10-40% Mineral Filled	30.00	70.00
PP, 10-40% Talc Filled	30.00	70.00
PP, 30-40% Glass Fiber-reinforced	30.00	45.00
PP (Polypropylene) Copolymer	20.00	28.00
PP (Polypropylene) Homopolymer	20.00	28.00
PP, Impact Modified	20.00	28.00
PPA - Polyphthalamide	20.80	20.90
PPA, 30% Mineral-filled	20.00	22.00
PPA, 33% Glass Fiber-reinforced	20.00	22.00
PPA, 33% Glass Fiber-reinforced – High Flow	18.00	20.00
PPA, 45% Glass Fiber-reinforced	22.00	24.00
PPE - Polyphenylene Ether	20.00	22.00
PPE, 30% Glass Fiber-reinforced	22.00	22.00
PPE, Flame Retardant	16.00	25.00
PPE, Impact Modified	1.000	1.100
PPS - Polyphenylene Sulfide	11.00	24.00
PPS, 20-30% Glass Fiber-reinforced	13.80	17.00
PPS, 40% Glass Fiber-reinforced	17.00	17.00
PPS, Glass fiber & Mineral-filled	13.00	13.00
PPSU - Polyphenylene Sulfone	14.20	20.00

PS (Polystyrene) 30% glass fiber	15.00	19.70
PS (Polystyrene) Crystal	16.00	28.00
PSU - Polysulfone	15.00	10.00
PSU, 30% Glass fiber-reinforced	16.90	40.00
PTFE - Polytetrafluoroethylene	17.00	24.00
PTFE, 25% Glass Fiber-reinforced	20.00	20.00
PVC, Plasticized	10.00	30.00
PVC, Plasticized Filled	10.00	30.00
PVC Rigid	10.00	40.00
PVDF - Polyvinylidene Fluoride	10.00	27.00
SAN - Styrene Acrylonitrile	12.00	24.00
SAN, 20% Glass Fiber-reinforced	19.70	20.00
SMA - Styrene Maleic Anhydride	16.00	16.00
SMA, 20% Glass Fiber-reinforced	21.00	21.00
SMMA - Styrene Methyl Methacrylate	19.70	19.70
UHMWPE - Ultra High Molecular Weight Polyethylene	28.00	28.00