

Volume Resistivity

Volume Resistivity of polymers material measures how strongly a plastic material opposes the flow of electric current through a volume of cubic specimen. The lower the resistivity the higher the conductivity (electric charges meet a weak resistance to circulation).

It is also known as electrical resistivity, bulk resistivity, specific electrical resistance, specific volume resistance, or simply resistivity.

Volume Resistivity is measured in units: ohm - meter (Ohm-m or Ohm-cm).

- » Below 10^5 Ohm.cm the material is considered as conductive.
- » Above 10^9 Ohm.cm the material is considered as an electrical insulator.

Check out more on Volume Resistivity:

- » **Volume Resistivity Values of Several Plastics**
- » **Importance of Volume Resistivity**
- » **How to Measure Volume Resistivity?**
- » **Volume Resistivity Vs Surface Resistivity**
- » **Factors Affecting Insulation Resistance**

Importance of Volume Resistivity

Volumes resistivity can be used as an aid in designing an insulator for a specific application. The change in resistivity with temperature and humidity may be great and must be known when designing for operating conditions.

Volumes resistivity determinations are often used in checking the uniformity of an insulating material, either with regards to:

- » Processing, or
- » Detect the conductive impurities that affect the quality of the material

Volume resistivities above $10^{21} \Omega \cdot \text{cm}$ ($10^{19} \Omega \cdot \text{m}$), calculated from data obtained on specimens tested under usual laboratory conditions, are of doubtful validity,

considering the limitations of commonly used measuring equipment.

Applications include:

- » Design of an insulator for a specific application
- » Screening of conductive pastes
- » Define applications for conducting composites

How to Measure Volume Resistivity?

The most usual test methods to determine plastics volume resistivity are ASTM D257, ASTM D4496-04, ASTM D991-89(2005) or IEC 60093 (*of course there exist several other methods as well!*)

In the usual test, a standard size specimen is placed between two electrodes. For sixty seconds, a voltage is applied and the resistance is measured. Volumetric resistivity is, then, calculated and the apparent value for a 60 second electrification time is given. A 4-inch disk is preferable as the specimen size for the test.

Volume Resistivity Vs Surface Resistivity

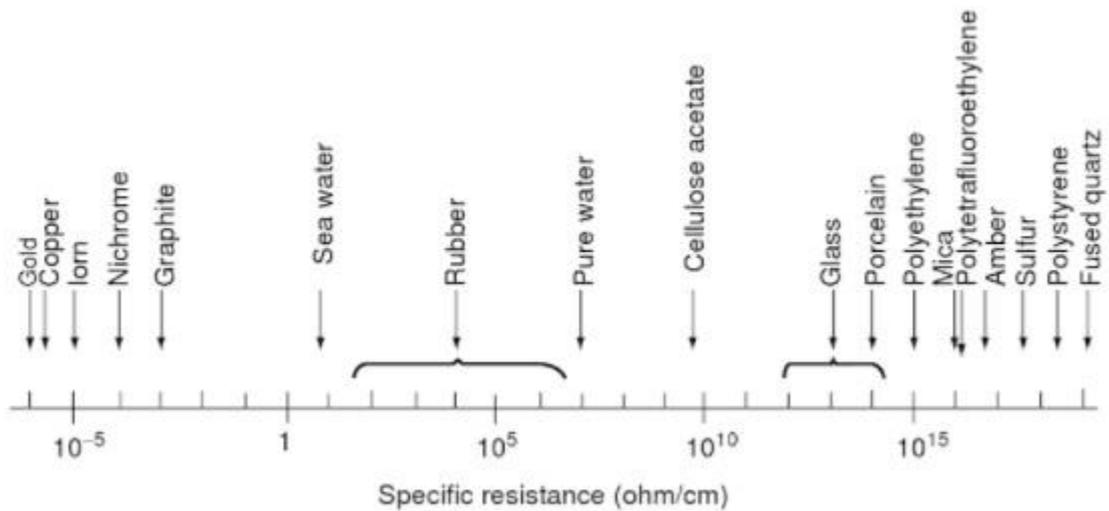
The resistance offered by an insulating material to the electric current is the composite effect of volume and surface resistances, which always act in parallel.

- Volume resistance is the resistance to leakage if the electric current passes through the body of the material.
 - It depends largely on the nature of the material
- On the other hand, surface resistance, which is the resistance to leakage along the surface of a material, is largely a function of surface finish and cleanliness
 - Surface resistance is reduced by oil or moisture on the surface and by surface roughness
 - And, very smooth or polished surface gives greater surface resistance

The insulation resistance of a dielectric is represented by its “Volume Resistivity” and “Surface Resistivity”.

The range of volume resistivities of different materials is shown below in ‘The

Resistivity Spectrum'



Source: Plastics Technology Handbook, Fifth Edition

Values for plastics typically range from 10^{10} ohm-cm for Cellulose Acetate to about 10^{19} ohm-cm for a high-performance polystyrene.

Factors Affecting Insulation Resistance

The insulation resistance of most plastics is affected by temperature and the relative humidity of the atmosphere

The insulation resistance falls off appreciably with an increase in temperature or humidity

Even PS, which has very high insulation resistance at room temperature, becomes generally unsatisfactory above 80°C (176°F). Under these conditions, polymers like PTFE and PCTFE are more suitable.

Plastics that have high water resistance are relatively less affected by high humidities.

The longer the voltage is applied (longer electrification times) the higher the volume resistivity that is measured.

The presence of fillers in the polymer will affect the volume resistivity. The type

and amount of filler change the volume resistivity.

Volume Resistivity Values of Several Plastics

Polymer Name	Min Value (10^{15} Ohm.cm)	Max Value (10^{15} Ohm.cm)
ABS - Acrylonitrile Butadiene Styrene	14.0	16.0
ABS Flame Retardant	14.0	15.0
ABS High Heat	16.0	16.0
ABS High Impact	16.0	16.0
ABS/PC Blend - Acrylonitrile Butadiene Styrene/Polycarbonate Blend	14.0	17.0
ABS/PC Blend 20% Glass Fiber	16.0	17.0
ABS/PC Flame Retardant	16.0	17.0
ASA - Acrylonitrile Styrene Acrylate	14.0	15.0
ASA/PC Blend - Acrylonitrile Styrene Acrylate/Polycarbonate Blend	13.05	15.0
ASA/PC Flame Retardant	14.0	14.0
CA - Cellulose Acetate	12.0	12.0
CAB - Cellulose Acetate Butyrate	13.0	13.0
CP - Cellulose Propionate	11.0	11.0
COC - Cyclic Olefin Copolymer	14.0	15.0
CPVC - Chlorinated Polyvinyl Chloride	15.0	16.0
ECTFE - Ethylene ChloroTriFluoroEthylene	16.0	16.0
ETFE - Ethylene Tetrafluoroethylene	15.0	17.0
EVA - Ethylene Vinyl Acetate	15.0	15.0

EVOH - Ethylene Vinyl Alcohol	12.0	13.0
FEP - Fluorinated Ethylene Propylene	17.0	18.0
HDPE - High Density Polyethylene	16.0	18.0
HIPS - High Impact Polystyrene	16.0	16.0
HIPS Flame Retardant V0	15.0	16.0
Ionomer (Ethylene-Methyl Acrylate Copolymer)	16.0	16.0
LCP - Liquid Crystal Polymer	16.0	16.0
LCP Carbon Fiber-reinforced	-1.0	-8.0
LCP Glass Fiber-reinforced	15.0	15.0
LCP Mineral-filled	12.0	16.0
LDPE - Low Density Polyethylene	0.917	0.940
LLDPE - Linear Low Density Polyethylene	16.0	18.0
MABS - Transparent Acrylonitrile Butadiene Styrene	13.0	14.0
PA 46 - Polyamide 46	15.0	15.0
PA 46, 30% Glass Fiber	10.0	13.0
PA 6 - Polyamide 6	14.0	14.0
PA 6-10 - Polyamide 6-10	14.0	14.0
PA 66 - Polyamide 6-6	14.0	14.0
PA 66, 30% Glass Fiber	13.0	13.0
PA 66, 30% Mineral filled	12.0	15.0
PA 66, Impact Modified, 15-30% Glass Fiber	12.0	13.0
PA 66, Impact Modified	11.0	15.0
PAI - Polyamide-Imide	12.0	17.0

PAI, 30% Glass Fiber	14.0	17.0
PAR - Polyarylate	16.0	17.0
PARA (Polyarylamide), 30-60% glass fiber	15.0	15.0
PBT - Polybutylene Terephthalate	14.0	17.0
PBT, 30% Glass Fiber	16.0	16.0
PC (Polycarbonate) 20-40% Glass Fiber	15.0	16.0
PC (Polycarbonate) 20-40% Glass Fiber Flame Retardant	15.0	17.0
PC - Polycarbonate, high heat	15.0	16.0
PC/PBT Blend - Polycarbonate/Polybutylene Terephthalate Blend	16.0	17.0
PC/PBT blend, Glass Filled	15.0	16.0
PCTFE - Polymonochlorotrifluoroethylene	14.0	15.0
PE - Polyethylene 30% Glass Fiber	16.0	16.0
PEEK - Polyetheretherketone	16.0	17.0
PEEK 30% Carbon Fiber-reinforced	1.0	8.0
PEEK 30% Glass Fiber-reinforced	15.0	16.0
PEI - Polyetherimide	5.0	18.0
PEI, 30% Glass Fiber-reinforced	15.0	16.0
PEKK (Polyetherketoneketone), Low Cristallinity Grade	1.0	1.0
PESU - Polyethersulfone	15.0	17.0
PESU 10-30% glass fiber	15.0	16.0
PET - Polyethylene Terephthalate	16.0	16.0
PET, 30% Glass Fiber-reinforced	15.0	16.0

PET, 30/35% Glass Fiber-reinforced, Impact Modified	0.0	2.0
PFA - Perfluoroalkoxy	16.0	18.0
PGA - Polyglycolides	1.400	1.600
PI - Polyimide	14.0	18.0
PMMA - Polymethylmethacrylate/Acrylic	14.0	16.0
PMMA (Acrylic) High Heat	15.0	15.0
PMMA (Acrylic) Impact Modified	14.0	16.0
PMP - Polymethylpentene	16.0	18.0
PMP 30% Glass Fiber-reinforced	16.0	17.0
PMP Mineral Filled	16.0	16.0
POM - Polyoxymethylene (Acetal)	14.0	15.0
POM (Acetal) Impact Modified	15.0	16.0
POM (Acetal) Low Friction	15.0	16.0
PP - Polypropylene 10-20% Glass Fiber	16.0	17.0
PP, 10-40% Mineral Filled	16.0	17.0
PP, 10-40% Talc Filled	16.0	17.0
PP, 30-40% Glass Fiber-reinforced	16.0	17.0
PP (Polypropylene) Copolymer	16.0	18.0
PP (Polypropylene) Homopolymer	16.0	18.0
PP, Impact Modified	16.0	18.0
PPA - Polyphthalamide	15.0	15.0
PPA, 30% Mineral-filled	14.0	16.0
PPA, 33% Glass Fiber-reinforced – High Flow	14.0	16.0

PPA, 45% Glass Fiber-reinforced	14.0	16.0
PPE - Polyphenylene Ether	15.0	16.0
PPE, 30% Glass Fiber-reinforced	15.0	16.0
PPE, Flame Retardant	15.0	16.0
PPS - Polyphenylene Sulfide	15.0	16.0
PPS, 20-30% Glass Fiber-reinforced	16.0	16.0
PPS, 40% Glass Fiber-reinforced	16.0	16.0
PPS, Conductive	1.0	3.0
PPS, Glass fiber & Mineral-filled	15.0	16.0
PPSU - Polyphenylene Sulfone	14.0	16.0
PS (Polystyrene) 30% glass fiber	16.0	16.0
PS (Polystyrene) Crystal	16.0	17.0
PS, High Heat	16.0	16.0
PSU - Polysulfone	15.0	17.0
PSU, 30% Glass fiber-reinforced	15.0	16.0
PSU Mineral Filled	16.0	16.0
PTFE - Polytetrafluoroethylene	17.0	18.0
PTFE, 25% Glass Fiber-reinforced	16.0	18.0
PVC (Polyvinyl Chloride), 20% Glass Fiber-reinforced	15.0	16.0
PVC, Plasticized	10.0	16.0
PVC, Plasticized Filled	10.0	16.0
PVC Rigid	15.0	16.0
PVDC - Polyvinylidene Chloride	15.0	16.0
PVDF - Polyvinylidene Fluoride	5.0	14.0
SAN - Styrene Acrylonitrile	16.0	16.0

SAN, 20% Glass Fiber-reinforced	15.0	17.0
SMA - Styrene Maleic Anhydride	16.0	16.0
SMA, 20% Glass Fiber-reinforced	15.0	15.0
SMMA - Styrene Methyl Methacrylate	15.0	15.0
UHMWPE - Ultra High Molecular Weight Polyethylene	16.0	17.0