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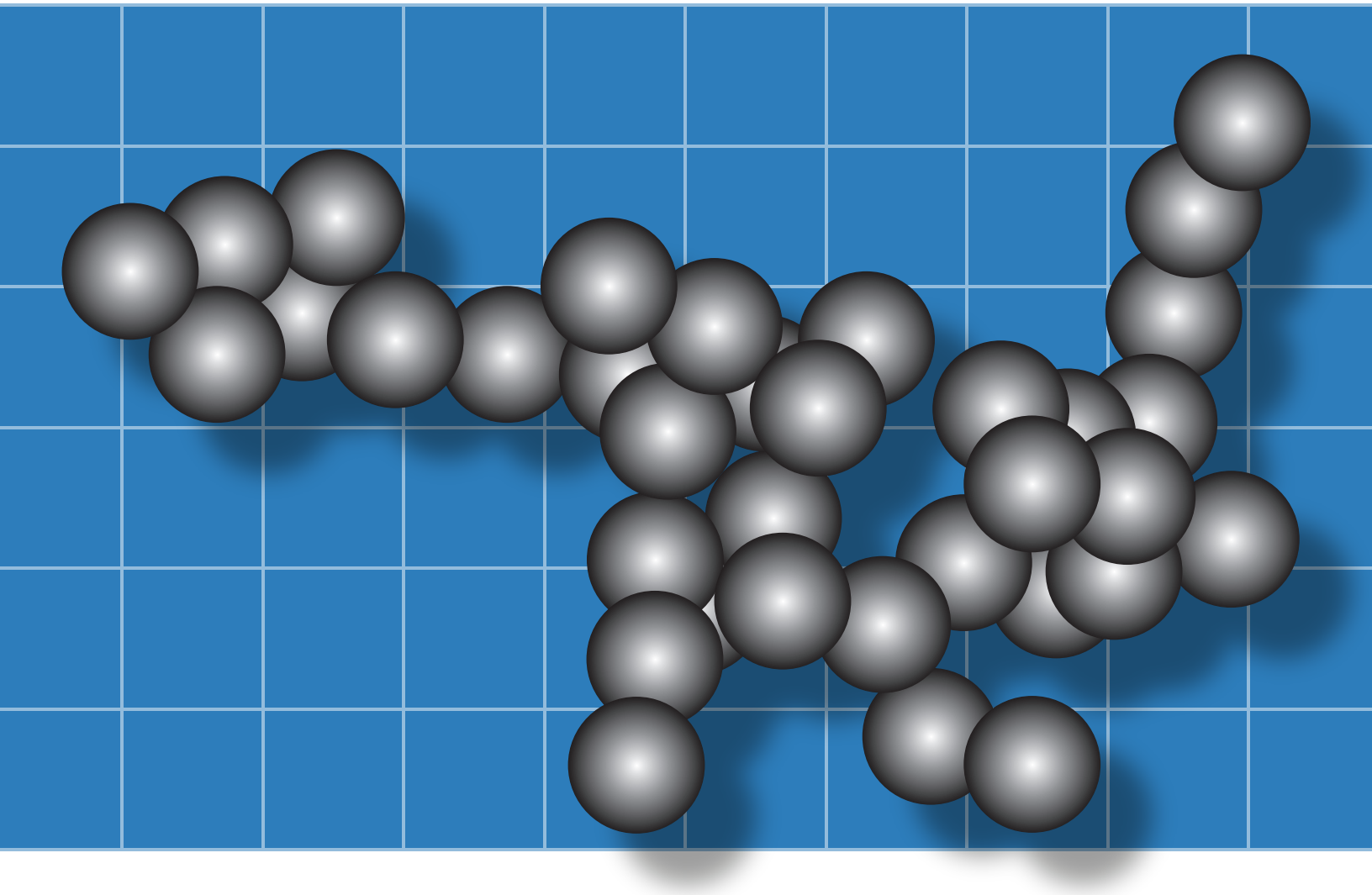
White Paper



Conductive Carbon Black Pigment

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Conductive Carbon Black Pigment and Its Use in Plastic Products

Over the years, carbon black has proven to be one of the most versatile materials to make many types of products. It is utilized in a host of applications such as conductive rubber, heating sheets, magnetic tapes, batteries, electrodes, inks, paints and coatings, and other uses. Some of the more innovative uses of carbon black pigment have come from the plastics industry, and more specifically in the fields of cables and electronics, automotive fuel systems, thermoformed trays and packaging to impart conductivity or electrostatic dissipation (ESD).

As few plastic resins are inherently conductive, it is necessary to add fillers such as metal powders or fibers. The most common filler used is carbon black, which can deliver the desired conductive or static dissipative qualities in a most cost-effective way. In many cases the compounds can offer other functional features as well. In addition to imparting color and electrical conductivity, carbon black also provides the lowest cost protection against UV light degradation of the polymer, making it ideal for outdoor uses.

Selection of the appropriate carbon black for use in the production of conductive or ESD compounds is based not only on the properties of the final compound, but also on the specific characteristics of the carbon black. The key carbon black properties are particle size, structure, purity and porosity. These critical features of the carbon black are then combined with various carrier resins in the compounding process to produce the product's desired performance criteria.

- Dependably exceptional dispersion
- Consistent particle size
- Integrity of the carbon black structure or network
- Specific resistance:
  - High: <10 ohm-cm
  - General: 10–100 ohm-cm
  - Antistatic: >1000 ohm-cm

Particle Size

When carbon black is incorporated into a polymer matrix, the size of the carbon black particles from <20 nm to 100 nm is the key to achieve optimum jetness and dispersibility. The particle size primarily relates to surface area. The finer the particle size, the larger the number of carbon black particles are present in the structure's surface. Generally the smaller the particle size, the deeper the jetness; however, the finer the particles are, the more difficult it becomes to get a good dispersion of the black pigment into the matrix.

Carbon Black Designations and Typical Particle Ranges

N-110: 11–19 nm
N-220: 20–25 nm
N-330: 26–30 nm
N-550: 40–48 nm
N-700: 61–100 nm

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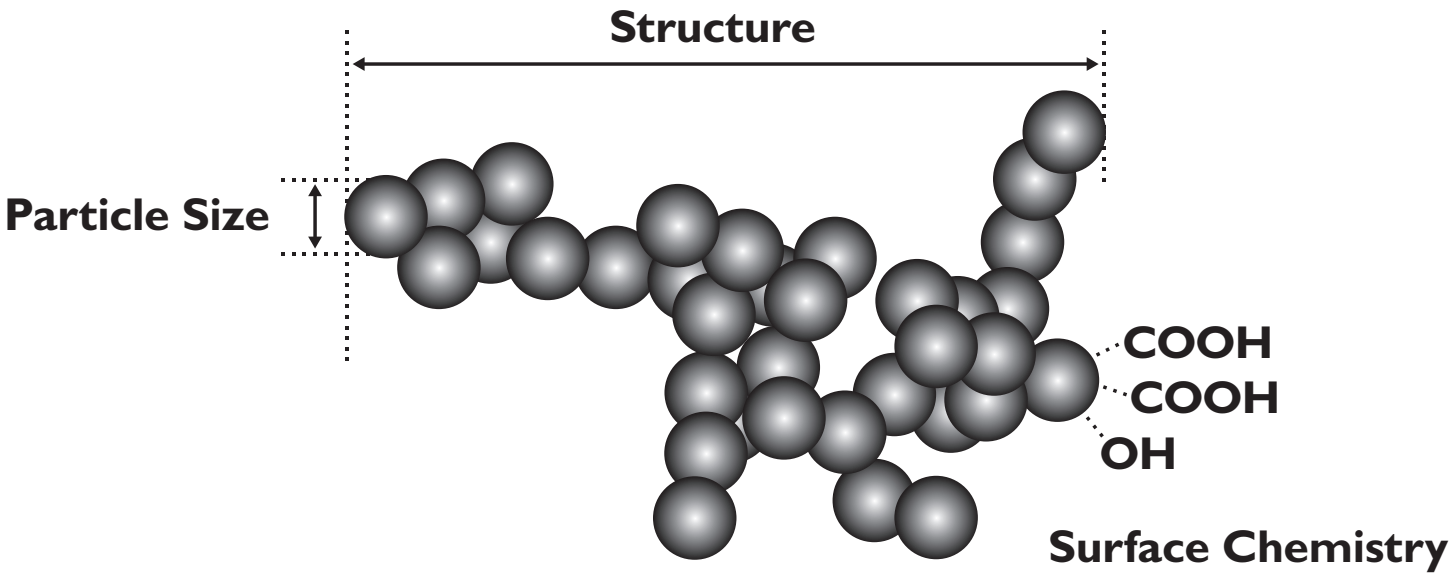
Structure

Like particle size, the type of molecular structure also affects the jetness and dispersibility of carbon black. The increase of structure size improves dispersibility but lowers jetness. The size and complexity of the structure is determined by the volume of primary black particles, which cluster together during the production process. The complex particle structure consists of branched chains with many secondarily created spaces in the aggregate. Carbon blacks with a more complex structure are easier to disperse and demonstrate the highest electrical conductivity.



Conductivity

Conductivity is measured by the surface resistivity (SR) of the conductive part. Enhanced conductivity performance for a conductive black compound will permit the design engineer to use the appropriate loading of carbon black to achieve the minimum required surface resistivity for each individual application.

Conductivity is dependent on several factors:

- The polymer matrix
- The type of conductive black
- The concentration of the conductive black
- The dispersion quality of the compound
- The distribution of the conductive black during extrusion

Volume Conductivity

Increased volume conductivity generally means decreased surface resistance. The graph below illustrates the internal resistance of various substances. To reduce internal resistance of a polymer, it is quite common to add carbon black. The necessary amount will vary, depending on the desired end properties of the polymer film or molded part.

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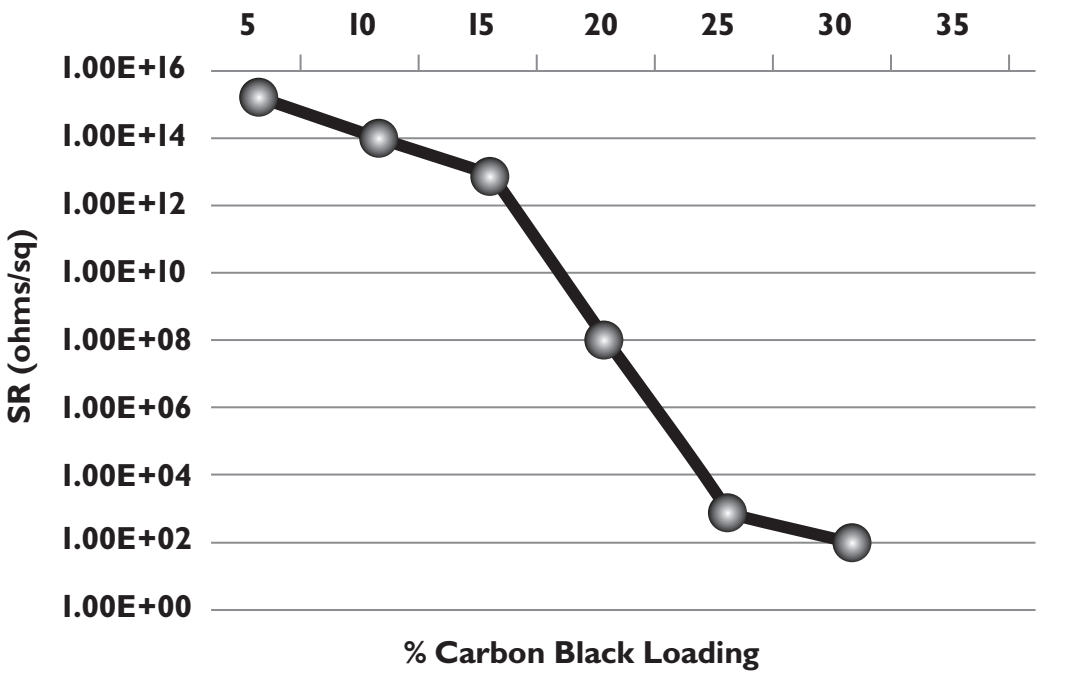
Surface Resistivity of Conductive Compounds



For customers, Ampacet's R&D Center in Terre Haute, Indiana can measure surface resistivity in a variety of finished products.

Static Build-Up

Static build-up and its associated problems are usually caused when certain materials are rubbed against each other, such as wool on plastic, or the polymer soles of shoes on carpeting. This can be a common household occurrence. The process causes electrons to be pulled from the surface of one material and relocated onto the surface of the other material. A static shock happens when the surface of a material, negatively charged with electrons, touches a positively charged conductor material, or vice versa. To avoid this type of electric shock, conductive black particles in a polymer can be utilized to achieve conductivity in fibers. Ampacet makes a specially formulated conductive black product for this type of application as static protection yarn and other end products.

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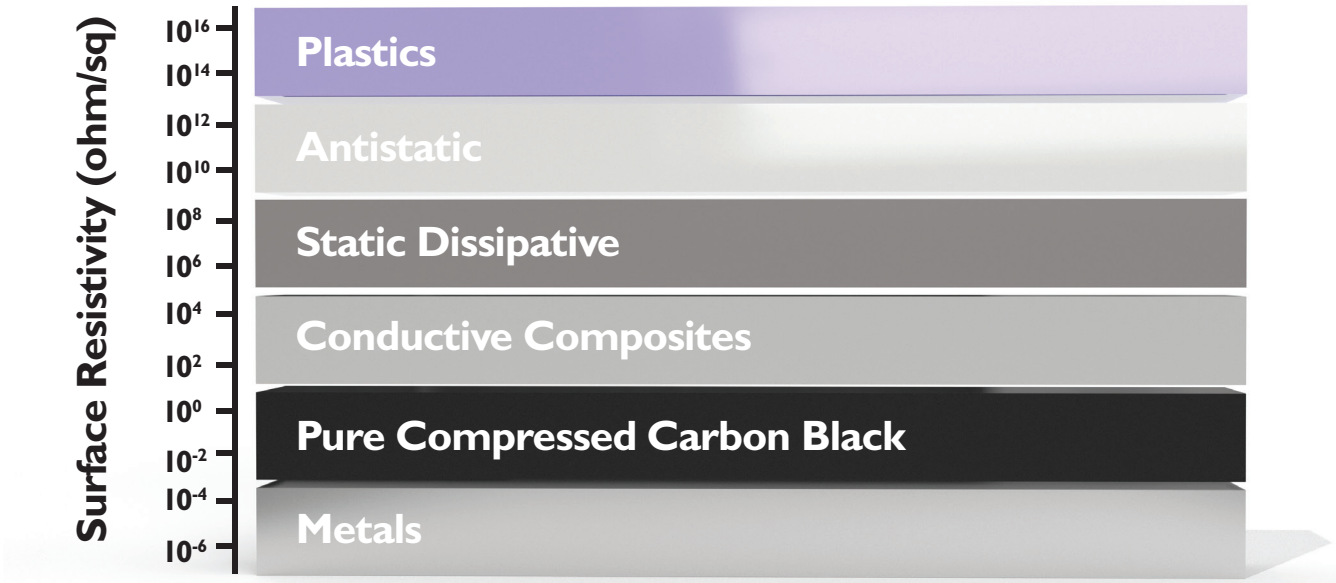
Electrical Resistance of Various Materials



Product Selection

Ampacet Corporation offers a number of high quality, performance oriented products using conductive carbon blacks. The following table provides a quick reference to the commercial offerings. Ampacet Corporation also will custom engineer products to meet the specific needs of most applications.

Product	% Carbon	Carrier Resin	Application	Features
7992749	25%	Co-polymer	Blown Film	Good Performance/ Cost Balance
190713	37%	Co-polymer	General	For Multiple Types of Extrusion
190802	26%	mLLD	Blown Film	Metallocene Base Adds Strength
192444	32%	LDPE	Fibers	

If your extrusion process or final polymer part is affected by electrostatic build-up or if enhanced conductivity is desired, it may be possible to solve these issues by using a conductive black masterbatch or compound. For assistance to determine the most suitable conductive black for your application, please contact your Ampacet sales representative.

About Ampacet

Founded in 1937, Ampacet Corporation is a leading global masterbatch supplier committed to designing innovative custom color, special effect, high performance and sustainable products and solutions. Ampacet also manufactures a proprietary line of machinery and feeders for the plastic industry aimed to improve efficiencies in plastics manufacturing.

Headquartered in Tarrytown, NY, Ampacet employs more than 2,000 people worldwide, with 25 manufacturing sites including technical and color development centers in 18 countries throughout the Americas, Asia and Europe.

Contact Us

Ampacet Corporation – US Headquarters
660 White Plains Road
Tarrytown, NY 10591
www.ampacet.com
(914) 631-6600