Ingenia Technical Brief

Carbon Black

From car interiors to garbage bags, black colored plastics can be found in countless applications. Common plastics such as polyethylene and polypropylene are naturally colorless. Carbon black is the world's most common black pigment, commonly used to impart a deep black color at low pigment loadings. Plastic parts can be made opaque with carbon black content as low as 1-3%.

Carbon black is a nanomaterial that has a long history of use as a colorant. Modern carbon black production involves heating a spray of liquid and gaseous hydrocarbons in a high-temperature, oxygen-restricted reactor. Carbon black particles form, grow, and clump together into **aggregates** as this process takes place. Aggregates can further join together to form difficult to disperse **agglomerates.** The ultimate size and shape of the particles can be tuned by customizing the reactor temperature, the hydrocarbon spray rate, and the amount of time the process is allowed to continue before water spray stops the process. This versatility allows for production of carbon black to be tuned for a specific final application.

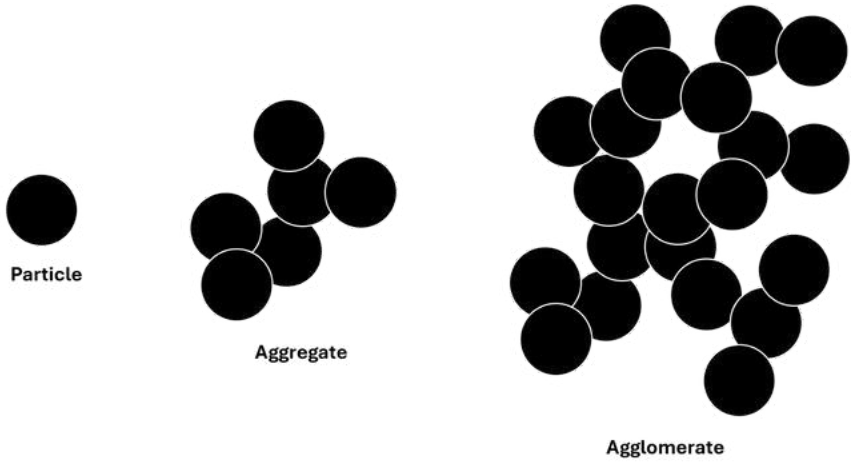

Figure 1. A representation of a carbon black particle, aggregate, and agglomerate.

Contact your Ingenia Polymer Sales or Technical Service Representative to learn more

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The properties of the final carbon black product are dictated by the size of the individual carbon black particles and the **structure** these particles form when they group together.

- The **particle size** is the greatest indicator of a carbon black color, jetness, and tint strength.
  - BET nitrogen adsorption and statistical thickness surface area (STSA) are used to measure the surface area (and therefore size) of carbon black particles.
  - A high surface correlates to a small particle size.
- Individual carbon black particles are very small. This causes them to clump together into complex, 3-D shapes with branches and clusters formed from individual particles. The complexity and size of these 3-D assemblies is called **structure.** Carbon black with high structure tends to have higher viscosity and can have improved electrical conductivity.
  - The structure of a carbon black grade can be indirectly determined by measuring its oil absorption number (OAN).
  - A high OAN correlates to higher structure.

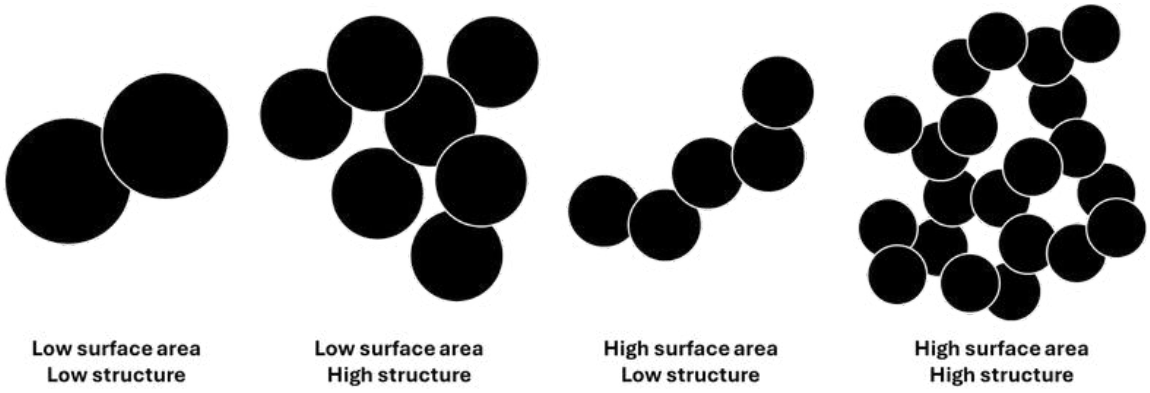

Figure 2. A schematic showing the difference in particles between high/low surface area carbon blacks.

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Carbon black is a powerful colorant and is sold as a fine powder or in beads. When used neat in extrusion, it can cause contamination problems on contact and surfaces, leading to dust buildup. As a fine powder, carbon black can pose health and safety concerns. Carbon black can also be difficult to dose accurately and can be hard to disperse in polyolefins, leading to hard grits or uneven coloring. To avoid this, carbon black can be compounded into highly loaded masterbatches. This provides a clean, pre-dispersed pellet that can be dosed accurately into a final application.

Carbon blacks that have small particle size and high structure have a high tint strength and jetness but have a higher viscosity and cannot be loaded as highly into a masterbatch. Another key difference between grades of carbon black with small vs. large particle sizes is the undertone of the black color. Large particles provide a bluer undertone while smaller particles provide a browner undertone.

A benefit to using carbon black in polyolefins is that the carbon black absorbs UV radiation from the sun, protecting the polymer from degradation. While most carbon black absorbs some UV radiation (thereby protecting the final product to some degree), the strongest UV absorption occurs with smaller carbon black particles. Carbon black also features excellent color fastness, sunlight does not cause degradation of the colorant.

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Traditionally, carbon black has been destined for the landfill at the end of its lifecycle. A more sustainable path has emerged with recovered carbon black (rCB). Automotive tires can be heated at high temperatures in an oxygen-free environment to remove the rubber, leaving only inorganic material. The resulting material is roughly 80% carbon black and 20% silica. rCB can be used in place of a traditional carbon black, with the understanding that the tint strength of the material will be lower due to the silica content.

Infrared light (IR) is used to sort plastics in recycling facilities. Unfortunately, carbon black strongly absorbs infrared light, making many black plastics difficult to sort and recycle. Several solutions exist in the marketplace, usually derived from a non-carbon black pigment. The use of these IR-detectable black pigments allow for the production of IR-sortable plastic products, enabling easier recycling.

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