



# Advanced Applications

## Electron Beam and Gamma Modification of Polymer Properties for Resins



Electron beam or gamma treatment of polymers after their transformation into semi- or fully- formed parts is a well established technique used to improve their end use performance. (Please refer to the Sterigenics brochure entitled “Electron Beam versus Chemical Crosslinking For Manufactured Parts.”)

However, electron beam or gamma treatment can also be used as a way to modify certain properties of polymers prior to their being processed into finished products. This processing method can be applied to either polymer pellets or powder.

This brochure explains the effects such treatments can have on pellets and powder (both thermoplastics and elastomers) and the practical benefits that are obtained.

### EFFECTS OF ELECTRON BEAM OR GAMMA TREATMENT ON POLYMERS

Electron beam or gamma treatment of polymers can provide three different effects, which can result in improved mechanical properties over the base resin or provide an improvement in processing characteristics. These include:

**Crosslinking:** *The formation of bonds between polymer chains, allowing them to link together.*

**Scissioning:** *The breaking of bonds in the main polymer chains.*

**Branching:** *The alteration of the number and types of side chains from the polymer backbone.*

The magnitudes of these effects depend on several variables, which include: the polymer selected for the application, the proper irradiation of the polymer, and handling of the polymer during the process.

Electron beam and gamma treatment of polymers to crosslink or scission polymer chains or alter their branches is particularly effective because:

- **No special additives are required**
- **The process is carefully controlled and reproducible**
- **A wide range of polymers may be processed**
- **The process reduces cost.**

### Property and End-Use Performance Improvements

Through the irradiation of polymers in pellet or powder form, functionality and performance of the finished parts using the polymers can improve significantly versus processing of the un-irradiated base resin. These improvements may be achieved from the ability to create long chain branching within the polymer as well as controlling the degree of crosslinking. Some of these improvements include:

- **Higher Mechanical Strength**
- **Improved Impact Strength**
- **Improved Wear Properties**
- **Improved Flame Retardancy**
- **Higher Environmental Stress Crack Resistance (ESCR)**
- **Improved Tear and Puncture Strength in Films**
- **Better Heat Sealing Properties**
- **Improved Burst Strength**
- **Improved Hydrostatic Strength in Pipe**



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Unlike the irradiation of finished parts, irradiation of many polymers in pellet or powder form often allows them to be fully recyclable. This results in a cost savings because the grind can be reprocessed into new, finished parts.

### Improved Processing Characteristics

Electron beam or gamma processing can provide solutions when a polymer or copolymer with sufficient properties for the end-product use does not have the necessary processing characteristics to produce the end product. Examples of undesirable processing characteristics are:

- **Melt viscosity is too low for stable extrusion**
- **Melt strength is insufficient for extrusion coating, blow molding etc.**
- **Surface tack is too high. (Typical of certain copolymers.)**

Creation of altered branching and low-density crosslinks between the chains can achieve numerous desired properties. In particular, melt viscosity and melt strength can be increased and surface tack can be reduced.

An example where scission is used to improve properties is enhancement of lubricating abilities of finely ground PTFE. These micro-powders are manufactured by using radiation scissioning so that the PTFE may be more easily ground to reduce particle size.

### Sterigenics Advanced Applications Radiation Processing Capability

Sterigenics Advanced Applications offers electron beam service and development centers located worldwide:

San Diego, CA  
Gaithersburg, MD  
Bridgeport, NJ  
Rayong Province, Thailand  
Espergaerde, Denmark  
Shanghai, China

Sterigenics also has gamma service centers in North America, Thailand, and Belgium.