

## **Electron Beam Effects on Polymers**

By Dr. Steve Lapin

March 10, 2010

Here is a summary of the effect of electron beam processing on some common materials used in the converting industry:

- Elastomers such as natural rubber, polybutadiene, and SBR: Most will undergo crosslinking.
- Polyethylene (LDPE, LLDPE, HDPE) and polyethylene copolymers such as EAA and EVA: Crosslinking; used for shrink films and physical property enhancement.
- Polypropylenes (BOPP): Chain scission can give a slight degradation in mechanical properties. This does not usually affect the functionality of the film at typical cure dose levels.
- Fluoropolymers: PTFE (Teflon) is degraded by EB. Little effect on PVDF at normal cure doses.
- PVC: Degraded by EB. Properties may still be acceptable at normal cure doses. Films will yellow. Color is easily visible in a roll but may be usable when viewing a single layer of film.
- Polyester (PET): Very resistant to EB effects.
- Polyamides (Nylon): Little effect on mechanical properties at typical cure dose levels. Color may be formed which fades and disappears in a few hours.
- Polystyrene: Very resistant to EB effects.
- Polysiloxanes (silicones): Will undergo crosslinking.
- Paper (cellulose): Chain scission. Some discoloration and off-odor may occur depending on the grade of paper that is used. Paper is widely used in EB converting without problems.

Notes:

- “Normal cure dose” means up to about 50 kGy. Some polymers are treated at much higher levels to intentionally induce crosslinking or scission effects.
- Atmosphere (air or nitrogen) can influence the effect EB will have on polymers.
- Polymer additives such as antioxidants and fillers can influence the effect EB will have on polymers.
- The crystallinity of a polymer can influence how it will be affected by EB.
- The temperature of the polymer during irradiation can also influence the effect EB will have.

Additional recommended reference: “Physical Properties of Polymers Handbook”, James E. Mark editor, ISBN 0387312358, Published by Springer, 2<sup>nd</sup> edition 2006.