factsheet

Low Energy Electron Beam

Low energy electron beams (LEEB), typically between 300 and 800 keV, have been used for many years to modify surface properties and decontaminate surfaces. Their low penetration depth allows for precise surface treatment without affecting underlying layers, and the compact, self-shielding accelerators can be mounted on production lines. There is growing interest in their use for industries such as medical device sterilization, pharmaceuticals, and food treatment.

E-BEAM COVER IMAGE: A low energy electron lamp from Comet

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The Technology

Produced with direct voltage accelerators, low energy e-beams are compact, cost-effective, and use no radioactive material.

These accelerators deliver high dose rates and are often self-shielding, enabling inline processing. The electron penetration depth is adjustable by changing the energy, making it suitable for treating surfaces of solids or thin liquid films. The size of LEEB systems depends on their power and application.

Current Applications

- **Electron Beam Curing:** Strengthens coatings without chemicals, used in materials like walls, floors, inks, and in-mold transfers.
- **Electron Beam Grafting:** Bonds materials without chemicals, enhancing properties like membrane durability, fiber wash resistance, and fire-proofing. It's used in medical applications for surfaces that promote cell adhesion.
- **Electron Beam Sterilization:** Sterilizes medical containers, devices, food packaging, and cosmetic containers. It's expanding for sterilizing packaging for liquids and sensitive products without damaging internal electronics.
- **Irradiation of Liquids:** Used for vaccine production, wastewater treatment, and biological applications due to precise penetration depth.
- **Electron Beam Food Treatment:** Effective for surface sterilization, killing insects, and preventing germination in products like seeds, grains, nuts, and spices. It's increasingly used for plant quarantining, such as fruit imports.

Tetra Pak® E3/Speed Hyper filling machine for the aseptic carton industry using e-beam sterilization

Zhiyan Technology LEEB machine
for surface irradiation curing of panels

Developing Applications

Interest is growing in four main areas:

- **Medical Product Sterilization:** Provides an alternative to EO sterilization, which faces regulatory restrictions. It is particularly suitable for products with simple geometries.
- **Pharmaceutical Packaging Sterilization:** Allows for surface treatment without damaging active ingredients, making inline processing feasible.
- **Food Treatment:** Enhances shelf life without damaging the food, with no residual radiation.
- **Blood irradiation:** Research in the irradiation of blood, plasma, cell suspensions, vaccines is ongoing..

Outlook

The benefits of low energy e-beams—compact size, low cost, high efficiency, and dose capacity—make them valuable for surface sterilization and modification. They can also generate X-rays for high penetration needs. Increasing supplier availability reflects growing interest in this technology.

X-rays

Low energy electrons can also produce X-rays using a heavy metal converter for deeper material penetration. However, efficiency is low (<1% below 1 MeV), with most energy lost as heat. This approach is suitable for treating thicker or denser materials.

Eb/X Systems and Supplier Database

The iia Eb/X Systems and Supplier Database provides details of organizations that are able to supply equipment and services to investors in industrial irradiation. This database includes Eb/X equipment suppliers with details of their location, irradiation technology and other services that they supply, and the typical applications that their technology can serve.

This database is available at this link to the iia website:
iiaglobal.com/iia-information-hub/eb-x-systems-and-suppliers