Improving Industrial Chemical Processes via Novel Electron Beam Accelerator

January 2020

E-beam accelerators – an established industry tool

Electron beams are an exceptional source of energy, capable of initiating chemical reactions without the need for catalysts, high temperature or high pressure. The high kinetic energy and penetrating nature of the electrons provide significant benefits over typical chemical methods.

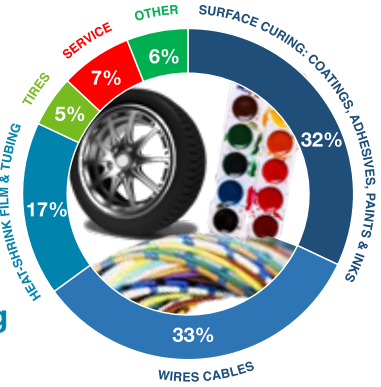
This technology is currently used in an array of industries and common consumer products. Accelerator sales eclipse $2B annually, providing an estimated added value to products worth more than $500B every year.

6% other

7% service

5% tires

17% heat-shrink film & tubing



32% surface curing: coatings, adhesives, paints & inks

33% wires & cables

Current End-use Market Distribution of E-Beam Industrial Applications

E-beam Applications Advantages

- **Improved** physical & chemical properties of existing materials
- **Enable** new materials synthesis routes

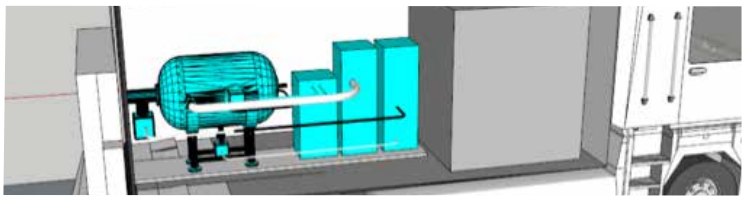
- **Eliminate** high temperature & high pressure
- **Continuous operation**
- **Increased** process yield

- Estimated **savings** compared to conventional tech
- Tire industry – **16% of manufacturing cost per tire**
- Cable insulation – **18% of avg. cost per km of product**
- Curing – **25-65% of manufacturing cost**

- **Eliminate** toxic byproducts by removal of chemical initiators, solvents and catalysts

Fermilab improvements over existing E-beam

- Superconducting technology increases energy efficiency by 50% and decreases overall OpEx costs by 30%
- Increased device power enables a high throughput rate
- Modeling and designing E-beam/target interaction area.
- New cooling approach reduces size from a three-story building to a compact and portable skid-mounted unit



The compact E-beam accelerator being developed at Fermilab will allow for increased application in industrial chemistry.

Emerging E-beam applications

- Fuel cell membranes – radiation grafting on fluoropolymers
- Petroleum industry – chain scission of hydrocarbons
- Carbon fiber modification – adhesion by crosslinking
- SiC fiber manufacturing – crosslinking
- Composites curing – crosslinking
- Rubber sheeting – crosslinking for roofing
- Biofuel production – scission of cellulose
- Stack gas treatment – radiolysis of gases

Current Opportunity

- Proof of principle work in Fermilab's applications development and development and demonstration E-beam accelerator (A2D2), potentially using simulants.
- Determining power requirements needed to deliver the required dose.
- Modeling shielding for high-powered E-beam and projecting the associated costs.
- Calculating the operational power and expense needed to meet the objective and comparing to alternative benchmarks.
- Modeling and designing E-beam/target interaction area.
- Investigating overall E-beam footprint and capital costs.
- Building a field demonstration unit. Low power unit already being oolsconstructed.

For more information contact

Slavica Grdanovska slavica@fnal.gov, http://iarc.fnal.gov/