

### ***UV/EB Curable Materials (94/95S3)***

Ultraviolet and electron beam (UV/EB) cured coatings and adhesives offer many attractive features. Excellent film properties can be achieved due to the high crosslinking density built up in situ. No solvents are needed, consequently no VOCs are lost to the environment or need to be controlled because the reactive diluents serve to provide viscosity control and reactivity. Other desirable features include high line speeds for high productivity, low energy use, low space requirements by obviating the need for long energy intensive drying ovens, and ambient temperature curing ideal for plastic and paper coating applications.

Because radiation curing (radcure) can make these claims it is the fastest growing segment of the coatings industry, albeit starting from a very small percentage of the entire market (1-3 percent). The bulk of ultraviolet/electron beam curable reactive diluents and resins is based on acrylate chemistry. Acrylates have evolved as the predominant chemistry for several reasons - low cost and ready availability of acrylic acid and derivatives, straightforward synthesis chemistry, good end use properties, and sometimes overlooked, the development and subsequent commercialization of effective free radical photoinitiators. Although acrylate based materials have allowed the development of a more than \$600 million radcure market, new materials and techniques will be needed to ensure continued growth.

A typical clear UV curable formulation consists of the following materials:

- Reactive diluents (20-50%)
- Resins (50-80%)
- Photoinitiator (0.5-5%)
- Additives (1-3%)

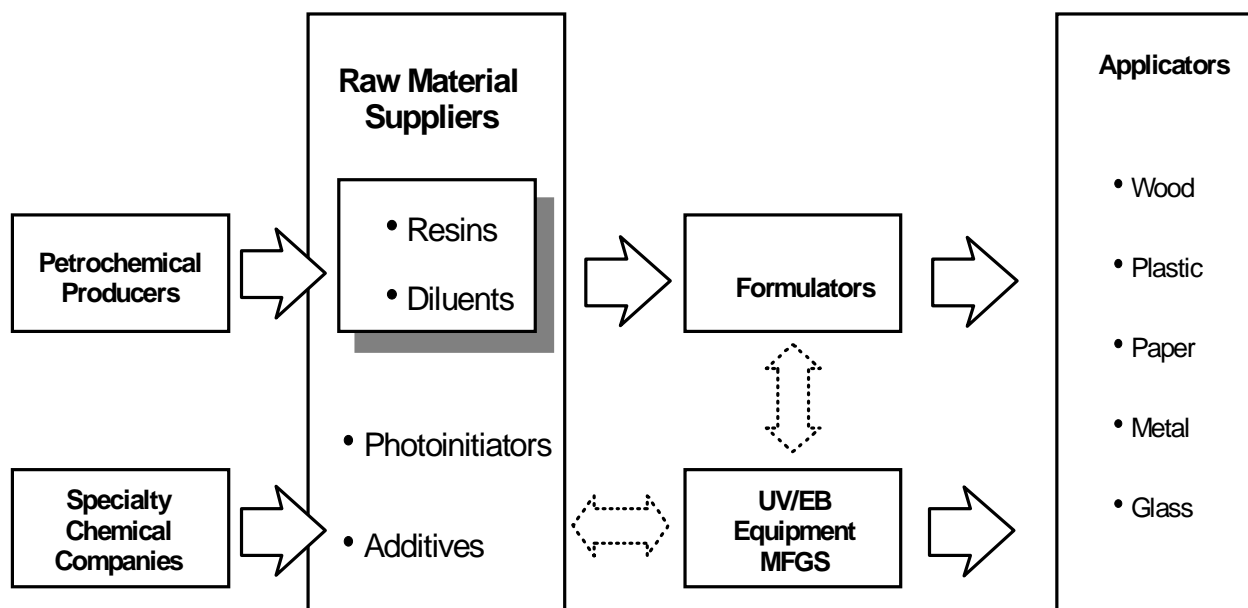
This report is primarily focused on reactive diluents and resins since these are the components that are manufactured from commodity petrochemicals. The photoinitiators and additives, although vital to the success of any particular formulation, are very small in volume and are considered specialties.

The industry structure of the radcure market is illustrated in the figure below. As shown the raw material suppliers furnish the resins, reactive diluents, photoinitiators, and additives

to the formulators. In many cases the resin and diluent manufacturer will supply all four of these categories of raw materials but typically will resell the photoinitiators and additives made by others. As highlighted in the figure the major petrochemical manufacturers supply the raw materials to the resin and diluent suppliers. Specialty chemical companies are typically the raw material suppliers to the producers of the photoinitiators and additives.

The formulators' role is to blend the ingredients made available from the raw material suppliers into uncured wet coatings and adhesives. The formulator must understand the end use property requirements of his customers' applications and his customers'

### INDUSTRY STRUCTURE OF RADCURE MARKET



economics. All formulation is a trade-off in properties and cost. Almost all properties can be formulated, but to do so at a cost that his customer can afford is the real value that experienced formulators provide.

The chemistry and economics of producing acrylate based diluents and resins are discussed. In addition, epoxy based materials and newly developed systems based on vinyl ethers and vinyl ether/maleates are also presented.