

UV & EB SILICONE RELEASE COATINGS

Release coatings, applied to various papers, film and other substrates, are extensively used providing release from a variety of products. Silicone release coatings in particular, (applied to paper or film substrates called release liners) are used in a wide variety of applications. The most significant applications by far are pressure sensitive adhesive (PSA) tapes and labels. Other applications include:

- *Self adhesive graphic and decorative products*
- *Vinyl wall coverings*
- *Personal hygiene products*
- *Transfer adhesives*
- *Baking papers*
- *Interleaving sheets*
- *Construction products*

Silicones are known chemically as polyorganosiloxanes. They are linear polymers with chains that can contain anywhere from 2 to over 1,000 silicone atoms, each linked to the next by an atom of oxygen. Different organic groups can be attached to the backbone to modify properties

Historically, the first silicone release coatings, commercialized in the decade of the 1950's, were solvent-based products using polydimethylsiloxane as the functional polymer. Later, water based and solvent-less 100% solids products were developed. All of these thermally oven cured systems utilize either a condensation reaction using silanol chemistry with a tin catalyst, or addition reaction chemistry using a vinyl functional polymer with a platinum or rhodium catalyst.

Silicone release coating systems cured by ultraviolet (UV) and electron beam (EB) curing processes have also been developed. These environmentally friendly silicone release coatings are either cationic epoxy-silicone or free radical acrylate-silicone functional chemistry products. Both are 100% solid, solvent-free, zero VOC products that are usually formulated to be applied as supplied. UV curing formulations containing photo initiators cure quickly under high-intensity ultraviolet light (medium pressure mercury vapor lamps). UV cured & EB cured formulations cross-link to create final film properties when irradiated. No heat is required for curing, allowing their use on heat sensitive substrates. Solvent-less, 100% solids UV & EB curable silicone release coatings bring relief to an industry that has been concerned with numerous environmental health and safety considerations resulting from using solvent based release coatings.

UV & EB curable silicone release coatings compete with solvent and emulsion silicone release coatings. Solvent-based coatings have been used successfully historically on a wide variety of films and smooth hard surfaced paper substrates. Emulsion release coatings are water-based coatings that offer similar performance to hydrocarbon solvent-based products. Both can be applied using simple direct gravure and Meyer rod coating techniques to obtain light coat weight application. Emulsion coatings have the advantage over solvent-based coatings in that they can be applied on size presses and they can be thickened with thickener additives so that they can be applied effectively onto porous substrates. Both solvent and water-based systems require large and costly drying systems in order to operate at high line speeds. The drying requirements can be detrimental when coating heat-sensitive plastic film substrates. Solvent systems also require a commitment to expensive solvent recovery or incineration processes.

UV & EB cured silicone release coatings, due to their 100% solids composition; require precision in application technique and equipment in order to achieve acceptable light coat weight application. However, many different processes including direct gravure and flexo may be used to accomplish effective application.

UV & EB silicone release coating formulations are well established as commercial products. They can be based on organo-functional polydimethylsiloxane (PDMS) or cycloaliphatic epoxy-functional PDMS used with compatible onium type catalysts. Importantly, the latter chemistry is cationic and cure is not inhibited by oxygen; because of this benefit, cationic epoxy-silicone release coatings are readily applicable to high-speed wide web radiation cure applications. Controlled release silicone release liners, used by the pressure sensitive adhesive (PSA) industry, are being produced more and more featuring cationic cured epoxy-silicone technology. Both UV & EB curing technologies are being used.

What is cationic chemistry? UV energy (light) exposure causes a cationic photo-initiator to release an acid catalyst. The acid catalyzes epoxide polymerization. There is an amount of post cure that takes place that further improves cured polymer properties.

Selected levels of release are possible ranging from very light and smooth to very tight. Release levels can be controlled by simple release coating formulation modifications. Other variables that affect release properties are the chemistry of the adhesive involved, effective curing and the final film weight of the release coating. Higher and continuous release coating film weights are more likely to seal a substrate, so less of the adhesive can attach itself to the substrate an action that can raise release values.

UV/EB PSA's (pressure sensitive adhesives) are also available and continue to be developed with the emergence of new raw materials. UV exposure cross-links these materials to attain their adhesive properties. Three types of products have emerged from development.

These are:

- *Liquid PSA's that coat at room temperature.*
- *Warm-Melt PSA's that coat at 200-250F to yield faster processing speeds and the ability to coat heat sensitive liner and face stock.*
- *Hot-Melt PSA's that coat at 300-350F to also yield improved processing speeds and additionally, high temperature shear, chemical resistance and high temperature adhesive performance.*

Currently radiation curable PSA's offer improved PSA performance benefits while providing total air pollution control, and exciting productivity gains including a huge reduction in manufacturing plant space requirements.

The use of UV/EB PSA's in conjunction with UV/EB curable release liners and UV/EB inks makes possible the capability of in-line label stock lamination processes. Picture a line running in excess of 1000 FPM producing printed label stock laminations in one in-line continuous UV/EB process.

These new PSA's may be directly cast onto silicone release liner after laminating (nipping) with film substrates after which the PSA laminate structure is cured. Additionally, UV cationic epoxy silicone PSA chemistry has been shown to be workable, directly casting, laminating and curing to UV cured cationic epoxy silicone release liner chemistry.

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