UV-Cure Temperature Maintains LightScribe Color Change Chemistry

By Susan E. Bailey

LightScribe is a color change technology used to label optical discs (CDs/DVDs). A thin coating on the optical disc is activated by the laser in the drive. A leuco dye and developer react to produce the color change. The LightScribe coating uses UV-curable acrylates as the matrix material that encompasses the color forming chemistry. The heat sensitive chemistry requires the use of low-temperature processing making the choice of a UV-curable system ideal. The properties of the coating and of the final film can be tailored by selection of monomers to suit process conditions.

Introduction

There are few options for consumers to label their optical discs that are quick and professional looking. Options open to industrial duplicators, such as screenprint or thermal re-transfer do not scale for the consumer market. Paper labels and inkjet printable discs can produce high-quality results. However, the extra hardware of a printer is required beyond the optical disc drive and your computer. In addition, consumable supplies are required, namely the ink in the printer and possibly the adhesive label. Paper labels have the additional problem of peeling off the disc and voids warrantee on the drive. Permanent markers are an option typically close at hand, but lack professional quality and the ability to incorporate images in the label content. The quantity of information that can be contained in the optical disc label is limited by the handwriting. And, even if the application does not require the professional quality or images, there is the problem that some permanent marker ink can adversely impact the data side of the optical disc.

This UV-curable system consists of a LightScribe enabled drive, imaging software and the UV-cured coated media.

Wouldn't it be nice if you could burn your data on an optical disc, and then burn an image on the label side using the same optical disc drive? With no additional printer hardware required, no ink to replace, just use your optical media and your computer with an optical drive[1] that is exactly what you can do with LightScribe, a technology developed by Hewlett-Packard Company. This system is comprised of specially coated optical media, imaging software and the optical disc drive that can recognize this media.

How It Works

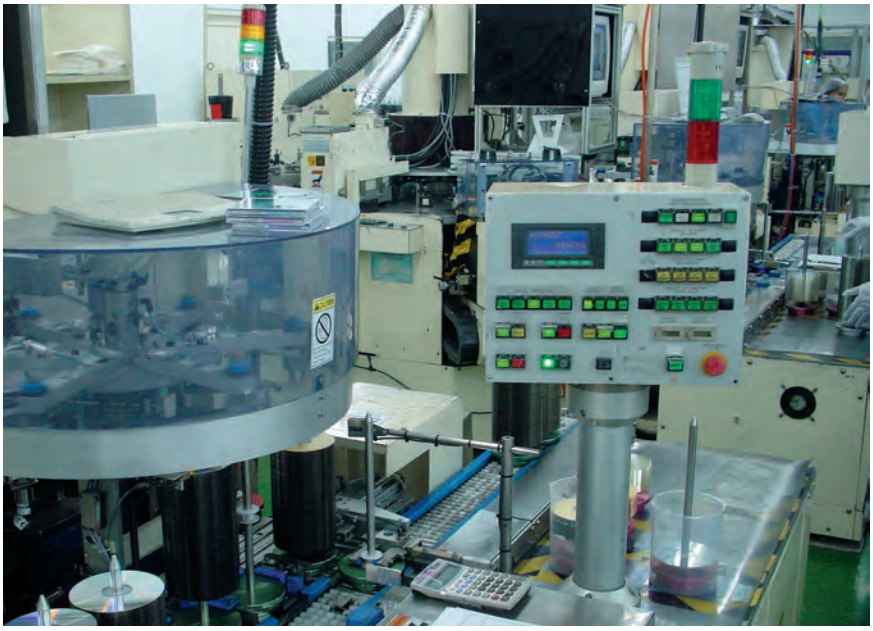
The consumer creates a disc label image using labeling software. When the label is ready to print, the disc is placed label side down in the drive. The drive recognizes the LightScribe media and burns the image on the label side using the same laser in the drive that writes the data.

This media has a thin coating on the label side of the disc. The coating is activated by the laser in the optical disc drive to produce a color change. The chemical basis for the color change is a leuco dye and developer interaction, similar to the technology used in thermal fax paper. The activation by the laser allows for the two components to react forming the dark mark against the lighter unmarked background.

Hewlett-Packard licenses the LightScribe technology to optical media, optical drive, and independent software manufacturers. Numerous PC OEMs, aftermarket optical drive brands, media brands and Independent Software Vendor (ISV) companies productized the technology. This technology was released to market in January 2005 and is now available worldwide.

Unique Coatings Require Unique Solutions

This media is composed of standard data side optical media with the LightScribe coating placed on the label side of the disc. Also unique to this media is a ring of highly reflective embossed features near the hub that allows for speed control and exact positioning of the laser beam in relation to the disc to create the mark. The coating layer is functional; hence, a consistent, defect-free, uniform coating is critical for the media. Label side coatings typically are applied to the optical discs using a screenprinting tool. These tools limit the coating viscosity. At too low of a viscosity, coating will drip through the screen. At too high of a viscosity, coating will not be uniform and streak during screenprinting. A common technique used to adjust viscosity for processing is to dilute a coating with solvent. However, dilution of the coating would cause variability in the color forming reaction, violating the key customer metric of image quality.



High-volume CD/DVD screenprinting lines at a manufacturer facility.

The viscosity of the coating can be fine tuned in an UV-cure chemistry system. For example, monomers that do not form hydrogen bonds can reduce viscosity in the coating. By selection of monomers, the viscosity can be tailored without diluting the coating with a solvent. This is an added benefit to high-volume media manufacturers whose speed is not limited by solvent evaporation. A 100% solids UV-cure system eliminates the need for volatile organic compounds (VOCs), which is better for the environment. The quality of the surface can also see an improvement, since surface defects often happen while the coating is drying.

The ability to activate the color change chemistry by laser exposure also makes the coating heat sensitive. The selection of matrix material to encompass the color forming reaction is complicated by this fact. Common binder materials are dissolved or dispersed in water or solvent. As part of the application process, the solvent or water must be removed. Typically this involves heat to evaporate the solvent or water before a hard coating is formed. Since heat will activate the color forming reaction, another matrix solution had to be found.

The low-temperature requirement is met by selection of a UV-curable matrix. By using a 100% solids UV-curable monomer base, no solvent needs to be evaporated. The coating can be applied to the optical disc and exposed to UV radiation to polymerize

The UV-curable matrix provides the low-temperature processing required for the heat sensitive color change chemistry.

CDs/DVDs produced using a new UV-curable system.

the coating. The resulting film is a hard coat, scratch resistant and well adhered to the surface. Low-processing temperatures maintain the color forming reaction. The requirement that the coating maintains a secondary chemical functionality after UV-cure polymerization makes the LightScribe coating unique in terms of UV coatings.

Monomers in the UV-cure system can be selected to provide the scratch resistance and other properties of the final film. Selecting a UV-cure system that will not shrink during cure promotes adhesion and avoids warping the optical disc. Flatness specifications ensure that the discs can be read by the optical drive; mild warping of the polycarbonate disc can render the discs unreadable. The functionality and glass transition temperature (T_g) of the monomers are two of the properties that can be tailored to tune final film properties. Higher functionality will lead to a greater degree of crosslinking, producing a quick-curing hard surface. The T_g of the monomer provides the ability to tune the flexibility of the film; a lower T_g allows the film to conform to the rigid polycarbonate substrate of the optical disc.

Summary

UV coatings are designed to be functional, with flexibility, strength and hardness. The LightScribe coating is unique among UV-cure coatings in its ability to retain a secondary chemical reaction, the color change, within the cured film. UV cure allows the process temperature to be kept low. The properties of the coating have been optimized; for screenprinting, however, the selection of monomers can be used to tailor this technology for many applications. Because of the process temperature and monomer selection, this system is able to provide a consistent, high quality experience to consumers.

References

1. Optical media and drive must be LightScribe enabled and will display the LightScribe logo.

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