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# Decorating Plastics with Lasers

**More data on parts, a larger array of laser markable resins, the need for more environmentally benign marking methods, and faster, cost-effective laser markers make lasers a good choice for this application**

Lasers have been used to decorate plastics since the early 1980s. Microelectronic packages and typewriter font cartridges were some of these early applications. Technological innovations both in the laser industry and plastic formulations have resulted in more widespread acceptance of lasers for plastic decoration. Today, several concurrent trends are focusing new light on decorating plastics with lasers.

## More parts Information

We live in a society where readily accessible information is required. Numerous factors cause manufacturers to put this information on every part. Laser markers can easily write high-resolution images that are dense with information on extremely small, complex parts. In order to read this information reliably, the plastic must be formulated to achieve a high-contrast, uniform mark.

There are numerous reasons to access even more information, some regulatory, some in an effort to make a product more user friendly. There is a need for product identity and operating instructions that survive the life of the product. In the global village this information is often required in more than one language. The need is greatest for those parts that have the highest liability if or when they fail. The part's production history and specifications need to be permanently marked in the part as exemplified by the nylon switch bodies shown in Figure 1. Traceability has become increasingly important as manufacturers use multinational vendors.

As parts become smaller and the data increases, the need for more innovative methods to convey information is required. For example, conventional bar codes are too big or often have the wrong form factor. Therefore, two-dimensional codes, such as ID Matrix shown in Figure 2, have been developed that have a data density 10-times conventional bar codes. Marking such codes requires ever more accurate and higher resolution marking techniques. Laser marking meets these requirements with spot sizes and mark position repeatability in the range of 0.001 inch. By comparison, pad printing or inkjet printers have a tough time marking parts with that kind of resolution and repeatability.

Example of dual marking head laser system (StarMark Performance Dual Head)

## Markable plastics

Resin and colorant suppliers have been busy developing more laser markable grades of resins. New formulations of base resin as well as custom additive packages are now available for many plastics such as acetal copolymer (POM), acrylonitrile-butadiene styrene (ABS), nylon, polycarbonate (PC), polyester (PBT), polypropylene (PP), polyurethane (PUR), and even polyphenylene sulfide (PPS). These plastics offer higher contrast and, in many cases, a pre-determined color when marked with a laser.

Entire assembled keyboard marked using a Nd:YAG Dual Head Laser in under 10 seconds. Keycaps are ABS plastic.

Agency logos and part information laser marked on nylon of various colors. Components marked in under 1 second per part using Nd:YAG Laser.

Legible images require excellent contrast between the laser marks and the base plastic. Contrast is particularly important for ultra-high density machine-readable matrix- or bar codes. Utilizing a C02 laser marker, commodity resins such as polypropylene filled with mica produce a frosted pale white mark. Using a Nd:YAG laser marker, darker colors of engineering resins such as ABS and PBT yield moderate to low contrast images unless reformulated for laser marking.

Compounding technology has advanced to the point that it is now possible to achieve near white marks in black or midnight blue acetal copolymer (POM) and off-white laser marks in dark ABS resins. It is also possible to achieve matched colors when using specific color formulations and laser parameters. In this way laser etched marks can be matched to Pantone, Munsell, or other industry standards (see Figure 3). The chroma, or hue, is determined by the pigment in the resin and the intensity, or shade, is determined by the laser settings. Because color also carries information, color-coded parts can simplify assembly, and corporate colors can help prevent counterfeiting.

## Environmental concerns

Exacting regulations continue to evolve to minimize the destruction of the environment. The printing industry has responded with new inks, solvents, and surface treatments, but many are still messy and expensive. By comparison, direct laser marking of a plastic part eliminates the consumable inks or chemicals and the drying process common to conventional printing.

The use of lasers for permanent identification of plastic parts offers more than just pretty color-an environmentally benign marking method. Although the printing industry has made enormous strides in developing alcohol- or water-based inks and surface pre-treatments to promote adhesion, many of the resulting processes can yield irreproducible adhesion and, sometimes, poor durability of the marks themselves.

Take for instance a design engineer's requirements for a strong, tough, chemically resistant and lubricious polymer for an automotive trunk release lever (described in ILR August 1997). The mark must last the life of the automobile and remain legible despite frequent rubbing and occasional contact with grease and oil. Furthermore, the marked lever must maintain its color, contrast, and mechanical properties even after prolonged exposure to sunlight. As chemically resistant polymers are hydrophobic and non-porous printing inks do not adhere well, the selected resin was a laser markable grade of acetal copolymer, Celcon LM90Z.

In order to use more conventional pad printing, surface cleaners and pre treatments such as chromic acid would be required. These chemicals require careful handling and disposal, not to mention the harm to the environment. Even with newer printing technologies such as corona discharge pre-treatment that are designed to be more environmentally friendly, the consumable costs are high. Ink and chemicals can cost $20,000 to $40,000 annually for a three-shift operation. In addition printing plates can cost upwards of $100,000 annually depending on their complexity, durability, and mark changes.

These direct costs are compounded by the hidden costs of time and floor space to dry the parts, special handling of printed parts, ordering, inventory and handling of consumables, waste disposal, and recycling. By comparison a laser marking system operating three shifts per year consumes less than $3000 in electricity. All other consumables such as lamps and filters cost less than $3500.

Laser marking eliminates printing plates, the inks and chemicals (therefore, no storage, waste disposal, or recycling costs), and the entire drying process. The fumes generated by the laser marking process are minimal and easily removed by an exhaust unit containing both HEPA and active charcoal filters. The laser marks are etched into the surface of the part and thus do not require any coatings or post processing. In addition, the repeatable laser marking process eliminates the value-added scrap of rejects common to pad printing. Laser marking is a cost-effective, environmentally clean method of decorating plastics.

## User friendly

Current laser marking systems are faster, smarter, and more cost effective than systems built just a few years ago. Today's systems use personal computers with straightforward graphics that can be easily programmed to mark unique data on each and every part, on the fly. Additionally, some manufacturers have developed systems that can mark two parts simultaneously using one laser source. This flexibility can save manufacturers thousands—or even hundreds of thousands—of dollars annually in changeover costs.

Ten years ago a system could mark approximately 40 type-size single stroke characters per second. Today, it is common to mark more than 400 characters per second—roughly a tenfold increase in writing speed.

One advancement that dramatically increases the productivity of a single laser marking system is the dual deflection head seen in Figure 4. With the addition of another deflection head and a programmable beam splitter, a single laser can simultaneously mark two parts with the same information, resulting in twice the performance at the operating cost of a single laser. Alternatively, the same system can mark a larger area without moving the part or tray of parts. This simplifies the material handling and, in the case of dual conveyors, virtually eliminates the part handling time from the overall cycle time.

A further advancement in dual deflection heads is asynchronous marking ability. In this configuration a single laser marking two parts simultaneously, but with unique marks on each part, produces a 101-key keyboard in less than 5 seconds.

Laser marking systems are far easier to program today with the help of colorful graphical Windows-based CAD style editors. A range of vector (DXF, SHP, HPGL, Type 1 fonts) and bit map images (PCX, TIF) can be imported as well as data from myriad sources. A user can create or revise mark layouts without extraordinary operator skill. A few manufacturers supply a database of laser settings compiled from their application labs that can be automatically assigned to drawing objects. In addition they supply a matrix program that helps the user quickly determine the best laser parameters for the mark they desire. With these tools it is practical to create marking programs that are broadcast to the production floor in real time. This ability fits in with the just-in-time manufacturing of today.

Programming of laser markers is easier today, as is calibration and troubleshooting. Taking full advantage of Windows' help structure, laser marker manufacturers have embedded service and calibration routines along with trouble tracking software to resolve interlock conditions. As a result the marking systems of today have a higher percentage uptime and longer mean-time to repair.

These trends, which are focusing new light on decorating plastics with lasers, pose new challenges for the manufacturer of plastic parts. The combination of lasers and laser markable resins is helping transform these challenges into exciting opportunities.

pharmaceutical industries have the greatest needs. Because of its small size and increased information capacity the 2D matrix symbology is leading the way in these industries.

## A 2D Overview

Data Matrix is a two-dimensional matrix symbology containing dark and light square data modules. It has a finder pattern of two solid lines and two alternating dark and light lines on the perimeter of the symbol. A two-dimensional imaging device such as a CCD camera is necessary to scan the symbology.

Data Matrix is designed with a fixed level of error correction capability. It supports industry-standard escape sequences to define international code pages and specialized encodation schemes. Data Matrix is used for small-item marking applications using a wide variety of printing and marking technologies.

Two dimensional codes fall in two basic categories. The **stacked bar code** is simply made up of thin slices of normal bar codes stacked on top of each other. The **matrix code**, unlike regular bar codes or stacked bar codes, is made up of individual elements or cells of equal size. These cells form a matrix similar to a checker board. Most often this matrix is symmetrical, meaning that it is as wide as it is high. The information is stored in the matrix by the selective placement of the black and white cells. Because this matrix can be made very


Example of DPY laser system (RS-Marker® PowerLine 100D)

dense, a large amount of information can be held in a very small area.

Each of these two dimensional formats have their own special applications. The stacked bar code can be read by raster scanning laser technology. Laser technology has been refined over many years and is readily available at very economical prices. While the density of the stacked bar code is not as great as the matrix code, the amount of information that can be encoded is the same.

Many applications which require a mixed environment of one dimensional and two dimensional symbologies will benefit from the use of the stacked bar code because of the compatible scanning technology. Matrix codes on the other hand can only be scanned using an area CCD imager.

Our Applications Specialists have a wealth of experience with all code types. We'd be happy to help you choose the best symbology for your needs.



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