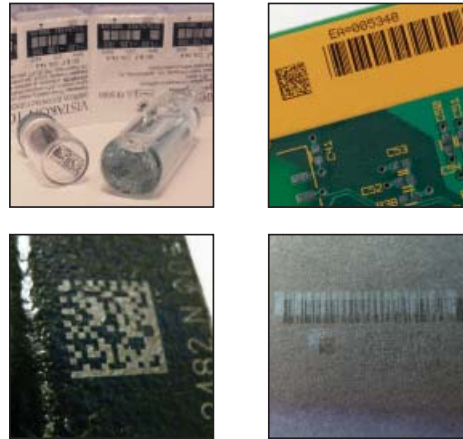


## Review of Direct Part Marking Methods

*While the overall concept of product tracking is not new, the automated tracking of products down to the individual part and component level has proven to have great bottom-line impact. The most direct way to ensure complete quality control of the production process is to mark objects with a machine-readable symbols and track them through the entire life cycle.*



### Many Marking Methods Are Available

There are many methods to directly mark objects. Selecting the best method for the application is critical to achieving success. Since each method has its own advantages and limitations, it is important to review and experiment with as many methods as possible before selecting the appropriate one.

#### Electro-Chemical Etch:

This marking process uses a low voltage electrical current to pass through a stencil to the part's surface. In order for this method to work, the part must have a conductive metal surface. This method will not work for anodized, powder-coated or non-conductive coatings. Unlike other permanent marking methods, electro-chemical etching does not weaken or distort metal parts because the molecular structure of the part is not altered beyond the depth of the mark. As a result, very thin-walled parts and those with fine surface finishes can be safely marked without damage. Since electro-chemical etching is a more involved process than other methods, it is not suited for highly automated applications and is commonly used for low volume product runs.

#### Ink Jet:

This type of marking uses small, dots sprayed directly onto the surface of the part. Ink jet typically produces high contrast marks, depending on the substrate and the ink color. Although permanent inks do exist, ink jet is not considered by some industry standards as a permanent marking method. Disadvantages include routine maintenance to prevent the jets from clogging, and the additional cost of consumables.






#### Laser Etch:






This marking type uses lasers to etch the symbol directly into the surface of the part. In addition to producing a clean, high resolution mark on a variety of substrates ranging from metal to plastics to glass, laser-etching is also well-suited for automated environments requiring high volumes. Since the top layer of the part's substrate is removed during the etching-process, sometimes the minimal residue that results may not be suited for some clean-room applications. The type of laser (Yag, CO2, YVO4) must be matched to the application and will affect price considerably. While laser etching equipment has a higher entry cost than many marking methods, there is no additional cost of consumables and maintenance is minimal.

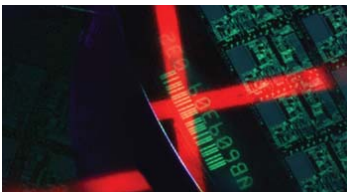
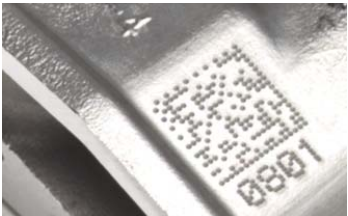

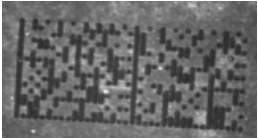
#### Dot Peen:

Dot Peen is a percussive marking method, using changes in depth to create the contrast between the light and dark elements of the symbol. Dot peen is recommended for applications where the symbol must last the entire life cycle of the part. In the aerospace and automotive industries, this can be several years. Suitable substrates for dot peen marking must have some hardness so material memory does not return the surface to its original condition.

On the following pages, a wide range of marking methods are discussed, including advantages and disadvantages.

Marking Method	Description	Advantages & Disadvantages
<p><b>Ink Jet on ABS plastic</b></p> 	<p>Contrast levels vary widely, round element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Post-packaging</li> <li>- Warehousing</li> <li>- Automotive</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Low-entry cost</li> <li>- High speed</li> <li>- Easy to read if contrast is good</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Not considered permanent by some industry standards</li> <li>- Dot registration can vary</li> <li>- Higher cost consumables</li> <li>- Mark quality dependant on surface cleanliness</li> <li>- Difficult to read if contrast poor</li> </ul>
<p><b>Pre-printed packaging</b></p> 	<p>Typically high contrast, square element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Product labeling</li> <li>- Product packaging</li> <li>- Document processing</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Economical</li> <li>- High speed</li> <li>- Good contrast</li> <li>- Easy to read</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Less flexibility</li> </ul>
<p><b>Thermal transfer label stock</b></p> 	<p>High contrast, typically black on white label stock, square element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Product labeling</li> <li>- Packaging</li> <li>- WIP tracking, various industries</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- High contrast</li> <li>- Low-entry cost</li> <li>- Easy to read</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Not permanent</li> <li>- Higher cost: consumables</li> </ul>
<p><b>Laser etch on silk screen</b></p> 	<p>High contrast, square &amp; round element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Electronics</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Good contrast</li> <li>- No consumables</li> <li>- Permanent</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Displaces surface</li> <li>- Process creates debris</li> </ul>
<p><b>Ink jet on plastic</b></p> 	<p>High or low contrast, round element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Bio-science</li> <li>- Pharmaceuticals</li> <li>- Packaging</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Limited damage to surface</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Higher cost consumables</li> <li>- Not permanent</li> <li>- Bleeding can affect mark quality</li> </ul>

Marking Method	Description	Advantages & Disadvantages
<p><b>Thermal print on foil packaging</b></p> 	<p>Typically good contrast, square element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Pharmaceutical Packaging</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Economical</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Reflective nature of marking method may require additional lighting</li> <li>- Deformation of surface may affect readability of code</li> </ul>
<p><b>Ink jet on glass</b></p> 	<p>Good contrast, round element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Pharmaceutical Packaging</li> <li>- Clinical R&amp;D</li> <li>- Electronics</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- High contrast</li> <li>- Low entry cost</li> <li>- Limited damage to surface</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Not permanent</li> <li>- Bleeding can affect mark quality</li> </ul>
<p><b>Laser etch on metal</b></p> 	<p>Low contrast, square element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Electronics</li> <li>- Automotive</li> <li>- Aerospace</li> <li>- DOD</li> <li>- Medical device</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Permanent</li> <li>- No consumables</li> <li>- High quality mark</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Process creates debris</li> <li>- Affects surface of substrate</li> </ul>
<p><b>Laser etch on glass epoxy</b></p> 	<p>Medium contrast, square element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Electronics</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Permanent</li> <li>- No consumables</li> <li>- High quality mark</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Process creates debris</li> <li>- Lack of contrast; difficult to read</li> <li>- Affects surface of substrate</li> </ul>
<p><b>Chem etch on metal</b></p> 	<p>Typically medium contrast, square element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Electronics</li> <li>- Semiconductor</li> <li>- DOD</li> <li>- Aerospace</li> <li>- Medical device</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Permanent</li> <li>- High quality mark</li> <li>- No debris from process</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Potentially toxic material byproduct</li> <li>- Low-volume use only</li> </ul>

Marking Method	Description	Advantages & Disadvantages
<p><b>Chem etch on silicon</b></p> 	<p>Typically medium contrast, square element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Semiconductor</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Permanent</li> <li>- High quality mark</li> <li>- No debris from process</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Potentially toxic material byproduct</li> <li>- Potentially complex process</li> </ul>
<p><b>Dot peen on smooth, highly reflective metal</b></p> 	<p>Low contrast, dependant on difference in depth to create light and dark elements. Round or square element shape, dependant on shape of stylus</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Automotive</li> <li>- Aerospace</li> <li>- DOD</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Permanent</li> <li>- No consumables</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Alters surface</li> <li>- Low contrast mark</li> <li>- More difficult to read</li> <li>- Inconsistent depth will create smaller elements</li> <li>- Background noise</li> </ul>
<p><b>Dot peen on machined metal</b></p> 	<p>Low contrast, dependant on difference in depth to create light and dark elements. Round or square element shape, dependant on shape of stylus</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Automotive</li> <li>- Aerospace</li> <li>- DOD</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Permanent</li> <li>- No consumables</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Alters surface</li> <li>- Low contrast mark</li> <li>- Very difficult to read, due to high degree of surface noise created by texture</li> </ul>
<p><b>Laser etch on rubber</b></p> 	<p>Very low contrast, square or round element shape</p> <p><b>Application:</b></p> <ul style="list-style-type: none"> <li>- Automotive</li> </ul>	<p><b>Advantage:</b></p> <ul style="list-style-type: none"> <li>- Permanent</li> <li>- No consumables</li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>- Process creates debris</li> <li>- Affects surface of substrate</li> </ul>

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