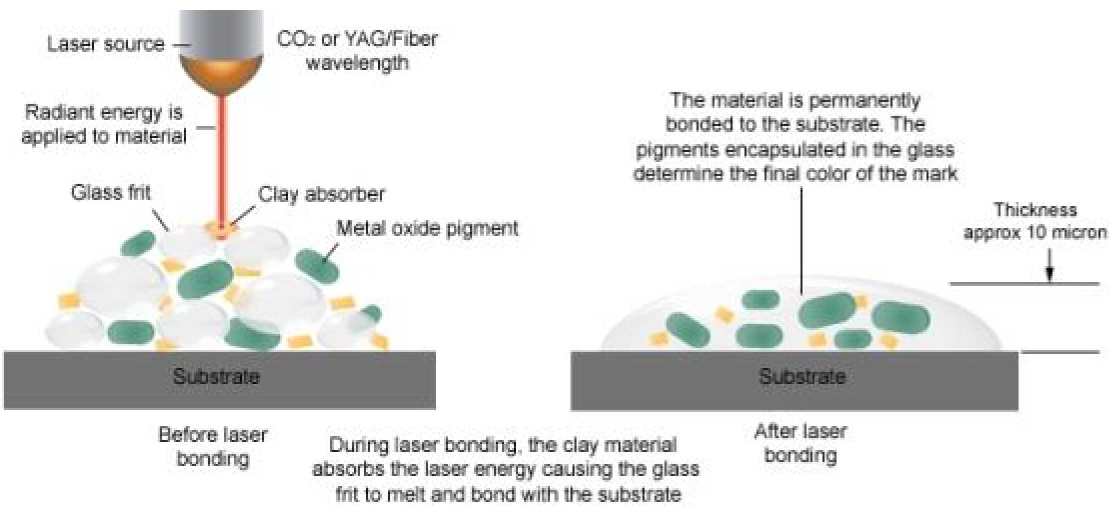
How TherMark Works

The revolutionary TherMark process uses precise lasers and marking materials scientifically formulated to permanently fuse to metals, ceramics, glass and other hard surfaces creating high-contrast, high-resolution marks. TherMark's patented technology offers an unmatched combination of benefits that stems directly from the chemistry involved in its laser marking process



TherMark's marking materials, or inks, consist of traditional ceramic glazing material, with the addition of a thermal absorber. The ceramic glazing material is a mixture of glass frit – small particles of partially fused glass designed to melt at a much lower temperature than ordinary window glass – with pigments for coloring. The traditional use of such glazing material requires it to be applied to the surface of a ceramic object, and then baked in a very hot kiln for more than an hour. Once fired, the glass frit and pigments combine to form a thin layer of colored glass that is further fused onto the surface of the ceramic object.

The patented TherMark method uses a laser as the heat source to fuse the ceramic glaze instead of a kiln. All this happens in microseconds as opposed to hours, consuming far less "energy" and, consequently, without compromising or damaging the material being marked. It is the thermal absorber within the TherMark marking materials which enhances and speeds the heat absorption from the laser beam, improving the transfer to the glaze. The thermal absorber is also instrumental in allowing the substrate to be marked using multiple laser types. For example, a CO2 laser cannot mark most metal because the beam cannot be absorbed by the substrate. Because of the absorbers, TherMark facilitates marking metals with a CO2 laser, increasing the range of applications the laser system is capable of.

The inclusion of pigments in the TherMark marking materials not only enables the creation of high-contrast, high-resolution marks, but also provides the ability of tailoring the color to the application. The pigments used are chemically similar, in many cases identical, to the ones used to decorate fine china, ceramics and tile. Some of these pigments undergo no chemical change during the laser firing process and either dissolve into or are simply encapsulated by the melting glass frit. Others react with the molten glass frit and with each other to “develop” the desired color under the laser’s heat. For example, TherMark uses a proprietary cobalt compound as a pigment which develops a deep blue color by reacting with the silicates in the glass frit to form Co-silicate.

In all cases, the result is a high-contrast, colored mark composed of inherently stable pigments which are further protected in capsules of inert glass.

The use of chemically stable pigments is one of two keys to the formation of permanent marks within the TherMark process. Equally important is the thermal bonding process. As the glass frit melts, it chemically bonds to the substrate’s surface. In the case of a glazed ceramic or glass substrate, silica atoms in the frit bond to the silica atoms in the ceramic glaze or the glass surface through an oxygen atom, as shown in Ilustration 2A below. In the case of unglazed ceramic or metal, silica atoms in the frit bond to metal atoms in the ceramic or metal surface, again through an oxygen atom as shown in Illustration 2B. These chemical bonds are as strong as the bonds holding the glass together and result in a mark that can stand up to severe abrasion and corrosion.

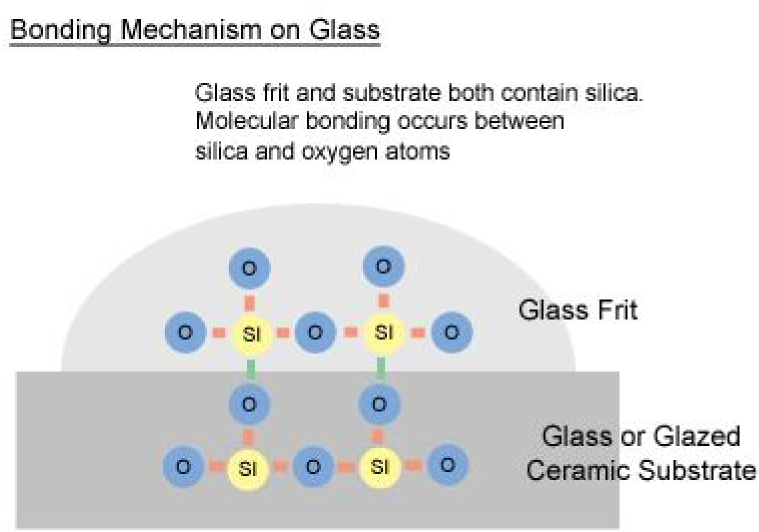


Illustration 2A

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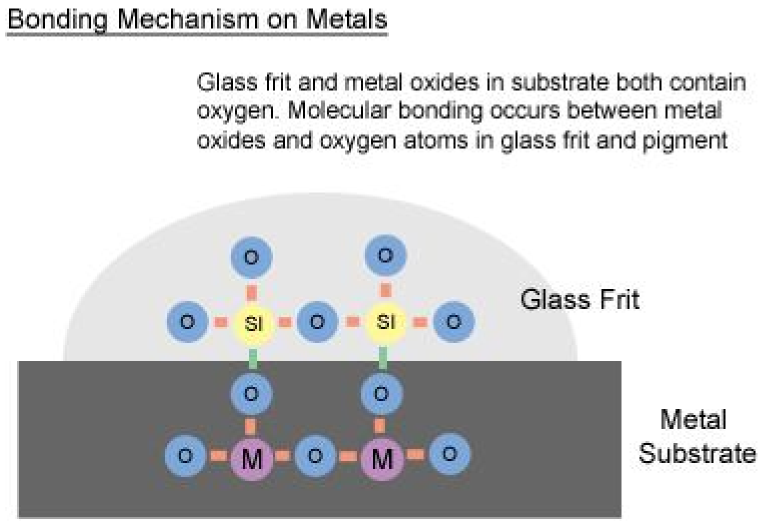

Illustration 2B

The components of the TherMark marking materials vary in order to address a wide variety of target substrates. Additionally, these marking materials are further mixed with either a liquid carrier - water or ethanol - for the ink and aerosols or otherwise bound to transfer tape.

A finished TherMark mark will deliver a unique combination of permanence, high contrast and high resolution, all while having minimal impact on the substrate being marked.

Permanence

The word permanence can be open to interpretation, with many claimed "permanent" marks being easily removed by chemicals or degrading over time. Because the TherMark material thermally bonds the glass frit and inorganic pigments it brings an unparalleled level of permanence to laser marking. This includes resistance to chemicals such as acids and bases, UV exposure, abrasion and extreme temperature.

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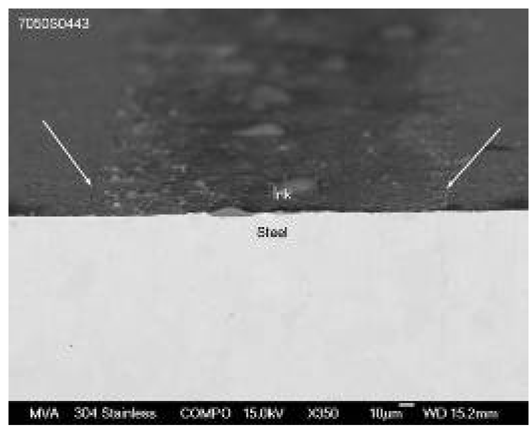
Contrast & Resolution
Whether you are looking for improved machine readability on barcodes, clear instructions or instant brand recognition on a decorative panel, TherMark laser marking materials offer a strong benefit. The laser bonding process delivers high resolution with variable data while the mark color provides a contrast with the substrate which may be missing with a direct mark. Improvements in contrast can lead to tangible cost savings in a manufacturing environment.

Effect on the Substrate

One of the main advantages of the TherMark laser marking process is it has a minimal effect on the integrity of the substrate being marked. Other direct marking solutions such as dot-peening and engraving physically indent or remove the surface making them unsuitable for plated or hard surfaces. Direct laser marks either ablate or anneal the substrate material which can lead to corrosion or structural change in the material. TherMark laser marking materials use less thermal energy to create a surface bond, preserving the substrate integrity and making them suitable for critical or difficult applications such as aerospace or industrial ceramics.



Cycle Time

There are a larger number of factors which impact the amount of time it will take to make your mark. In many instances, the addition of a TherMark laser marking material will decrease your marking time.

The process window for creating an excellent mark with TherMark laser marking materials ranges from quite easy to challenging depending on a number of variables which can affect the marking process. The more these variables are recognized, understood, and adjusted for, the better your marks will be.

Laser variation

Despite lasers being specified as having a specific output power, the reality is that many lasers are not actually delivering the exact power advertised. This variation is not normally extreme, but some lasers vary as much as 5-10% from what their manufacturers describe. In most cases this is easily adjusted for by increasing or decreasing the power of the laser during the marking process. However, for our customers with lower power lasers, this can be a potential problem if their laser cannot deliver the minimum power needed to create a mark.
The laser beam in laser marking systems is focused through a lens which focuses the beam on to the surface to be marked. The focal spot size of the laser beam directly relates to the energy density of the beam: the tighter the focus, the higher the energy density and vice versa. Different lenses will focus the same beam differently resulting in a large variation of spot sizes from laser to laser, and thus of energy density, for the same output powers. Moreover, the laser beam quality (M2 value in technical terms) will strongly affect its focusing properties, the focal spot size, and consequently the energy density at the focus. Hence, proper adjustment of laser settings will be needed for successful marking.

Tip: It is a good idea always to do a test power grid on a scrap part before moving to production pieces. This will enable you to determine your own optimal settings for *your* laser.

Substrate variation

Variation in substrate composition is something to be aware of when marking metals with TherMark laser marking materials. If your parts to be marked do not have a consistent metallurgy or composition they may each react differently with our materials. When doing large production runs it is important to use parts that have the same composition in order to achieve consistent marks.

Tip: When changing suppliers, make sure to test new parts and adjust your laser settings as appropriate.

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Thermal conductivity of the substrate

The optimum marking settings will also depend on the *thermal conductivity* of the substrate being marked. The reason for this is that to successfully bond to the substrate the laser beam should heat the frit in the ink to certain high temperatures locally. When marking materials with high thermal conductivity, heat can dissipate due to thermal conduction. Therefore, higher settings may be required. With the same token, different materials have different *heat capacities*, which is the amount of energy required to increase the temperature by one degree. These two parameters combined will define the optimum settings required for each substrate. Usually metals require higher powers than plastics or glass materials.

Substrate thickness

The above mentioned parameters of thermal conductivity and heat capacity directly relate to the shape and volume of the object being marked. Thin substrates such as thin sheets of metals, for example, are much easier to heat up than bulk metals and may require slightly lower powers for marking. This is also a relevant issue when marking plated materials. For example, one may want to mark a chrome plated brass object, where the mark should be bonded to the thin layer of chrome plating. In this case, the power settings for laser marking should be lower than in a case of marking a bulk chrome so as not to damage the thin layer