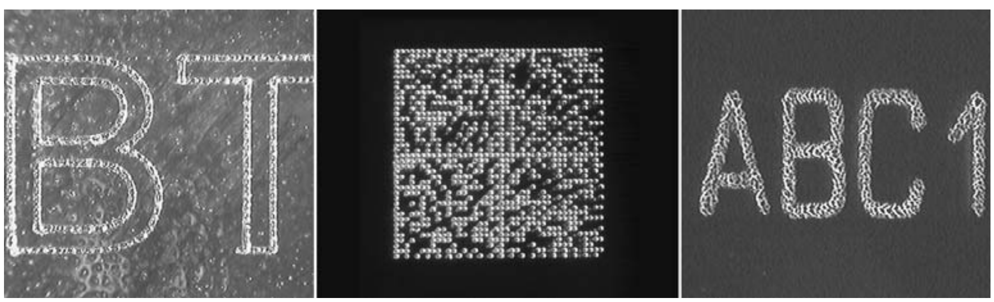
Glass Marking Techniques using CO_2 Lasers

Glass manufacturers and fabricators have long expressed interest in CO_2 lasers for marking serial numbers, logos, and codes on automotive glass, medical devices, windows, and electronic parts. The problem, until recently, though, was that CO_2 lasers typically produced highly fractured marks on most glass types. New techniques have made it possible to produce crisp, high quality marks directly on glass with sealed CO_2 lasers, making them an attractive alternative to traditional glass marking methods and expensive solid-state laser solutions. A 25-watt CO_2 laser provides sufficient power for most glass marking applications.

By definition, CO_2 lasers mark glass by fracturing its surface, so in all cases, a certain amount of fracturing of the material is necessary. Excessive fracturing, however, can result in difficulties with readability, potential weakening of the material, and most notably, the formation of loose chips. These problems can be eliminated by carefully controlling the amount of fracture that takes place during the marking process.



Marks made on glass using the three marking methods described below: left, made using muiltiple laser passes; middle, discrete spots form ring fractures; right, creating a crazed surface fracture.

There are three techniques that can be used in controlling the amount and type of fracturing induced on the glass surface. The first relies on using multiple laser passes, the second uses discrete spots to form ring fractures, and the third produces a crazed surface fracture.

A mark made using a single pass will produce a bold visible mark on glass, but fractures and stress patterns will extend perpendicularly to the direction of laser motion. After a period of time, even days after the mark is made, these perpendicular fractures will form new fractures adjacent to the marked area, which can form debris and affect readability. The use of multiple laser passes allows the material adjacent to the desired mark area to be heated through conduction, which helps to form a stress gradient that reduces the chances of secondary fracturing. This method is effective for marking on soda lime and borosilicate glasses. Single pass marks work well on fused silica and quartz glasses due to their low expansion coefficient.

The second method is an adaptation of techniques used in producing low stiction areas at the start and stop points on magnetic disk media. A series of ring fractures can be used to form text, bar codes, square or rectangular Data Matrix™ codes, and QR™ codes. The glass goes through a heating and cooling cycle that produces a low-density circular formation. The glass expands when heated, pushing against the surrounding material. When the softening point is reached, the glass expands radially, forming a dome of low-density material that protrudes above the surface. After heating, the glass contracts back to its original surface position, but the relaxation time is such that the entire low-density formation cannot return to its starting point before the softening temperature is reached. The Gaussian nature of the spot results in greater heating at the spot center. This hot region will return close to its original position and form an anchor for the ring fracture. The juncture between low-density formation and normalized material allows for the formation of stable circular fractures. This method works well for marking common optical materials and tempered, chemically strengthened, or plain soda lime float glass.

The third method involves the same heating and cooling cycle that gives rise to the changes in specific volume of the glass surface. However, a larger spot size is used (typically around 500 microns) and does not produce the same sharp junction used in the ring fracture method. The mark produced is not immediately visible and requires a slight amount of pressure to begin fracturing that will cascade along the laser marked area. Filled text, graphics, and codes can be produced with no debris. As this method requires a pristine surface, the high quality of automotive glass produces exceptional results.

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