# QQC DIAMOND COATING

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QQC, a revolutionary process, can deposit a uniform layer of diamond on almost any type of material ranging from glass and plastic to metals. It is done using the carbon dioxide from the air as the carbon source and subjecting it to a combination of lasers to do in seconds what takes conventional chemical vapor deposition (CVD) processes hours. This relatively new laser process creates pure diamond and bonds it to a surface of a material with the ease of paint on a brush.

Imagine having a pair of eyeglasses and windshields where the lens or surface never scratches or a kitchen knife that never dulls. It is possible to coat the cutting edges of all types of tools that will last much longer and dull only after prolonged use. Longer-lasting tools, instruments, windshields, and everyday goods are only a few of the applications for diamond coating available today.

**Chemical Vapor Deposition (CVD) Process**

1. CVD on the other hand, can be directly synthesized (coated) to a cutting tool substrate, eliminating many steps in the PCD fabrication process. It also allows diamond to be used on intricate shapes such as cutting tool inserts with molded-in chip breaker geometry, twist drills, and taps.

**A Diamond Coating Breakthrough**

A major breakthrough in diamond deposition technology occurred when Pravin Mistry, a metallurgist was doing independent materials research and consulting to industries requiring better tooling for metal forming and extrusion. He was working towards fabricating hard materials, using lasers to synthesize ceramics and metal-matrix composites (MMC) on aluminum extrusion dies to improve their performance and longevity. In a fortunate misstep during laser synthesis of titanium diboride, Mistry switched carbon dioxide for nitrogen and produced a coating speckled with some black particulate inclusions.

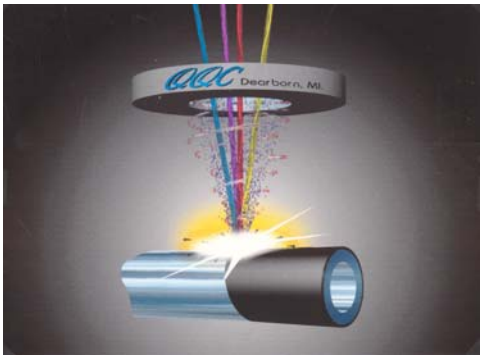
Analysis of the coating's surface indicated the presence of polycrystalline diamond. The QQC Diamond coating process uses the carbon dioxide from the atmosphere as the carbon source and subjects it to multiplexed lasers to produce diamond film that can be deposited onto almost any material.

**THE QQC PROCESS**

Briefly describing the process it consists of:

1. Laser energy directed at a substrate to mobilize, vaporize and react a constituent (primary) element (e.g., carbon) contained within the substrate.
    - This changes the crystalline structure of the basic element, and spreads a coating on the material.
    - This results in diffusion bonding of the coating to the material.
2. The laser energy is provided by a combination of different lasers.
    - The output beams are directed through a nozzle delivering the secondary element to the reaction zone.
    - The reaction zone is shielded by a non-reactive shielding gas delivered through the nozzle.
    - A flat plasma is created by the lasers, constituent element and secondary element on the surface of the substrate to create the coating.

Certain advantageous metallurgical changes are created in the substrate due to the pretreatment. The processes are suitably performed in ambient, without preheating the substrate and without a vacuum.




The QQC approach creates diamond in an ordinary atmosphere, not the high-temperature vacuum used in standard diamond manufacture. Multiple laser beams are directed through a cloud of carbon dioxide at a tungsten carbide surface. The lasers break the carbon dioxide into oxygen and carbon. Diamond is formed from the bonding of this carbon with carbon atoms that the laser energy has put into motion from the rotating surface of the object.

**Diamond Thickness**

The thickest layer of diamond made so far by the QQC process has been 1,000 microns, compared with the 7 to 22 micron layers usually created by CVD. After the lasers painted one object in new pure diamond, the heat generated was about the warmth of hot toast.

Most amazing is how fast the diamond forms, at a rate of about one micron per second, while it bonds metallurgicaly to the surface below. This compares to a few microns per hour for CVD.

**ADVANTAGES**

Key advantages of the QQC system's process over existing technology include:

- Superior adhesion and reduced stress result from a metallurgical bond between the diamond and substrate.
- The process is carried out in atmosphere, without the restrictions of a vacuum chamber. Almost any size or shape can be coated by controlling movements of the lasers or workpiece.
- Pretreatment and/or preheating of the substrate is not required, permitting coating of the substrate of as-manufactured components and elimination of wet chemistry pretreatment.
- Only carbon dioxide is used as a primary/secondary source for carbon with nitrogen acting as a shield and possible stockpiling process ingredient. This replaces the use of dangerous gases such as hydrogen and methane, critical ingredients in the CVD process.
- Deposition rates are dramatically increased, with linear growth rates exceeding 1 micron per second as opposed to 1 to 5 microns per hour by CVD.
- The process can be applied to almost any substrate such as stainless steel, high-speed steel, iron, plastic, glass, copper, aluminum, titanium and silicon.