DIRECT METAL DEPOSITION

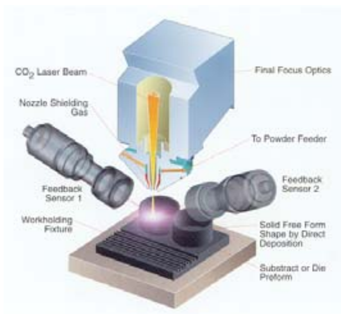
(Manufacturing at the Speed of Light) **Steve Krar**

With new technologies evolving almost every week, it was just a matter of time before someone would experiment by blending a number of technologies to come up with something new. POM, Inc., (Precision Optical Manufacturing) of Auburn Hills MI combined CAD, CAM, lasers, sensors, and powder metallurgy to develop the Direct Metal Deposition (DMD) process. It might well be the **PUT-ON** tool many of us wished we had after making machining errors during our early years in the trade.

Direct Metal Deposition (DMD)™

DMD is a form of rapid tooling process that makes parts and molds from metal powder that is melted by a laser, and then solidified in place. This process closely resembles conventional rapid prototyping processes (material processed by laser under computer control) but differs in that metal powder, and even tool steel, can be melted rather than plastic polymers. DMD allows the production or reconfiguration of parts, molds and dies that are made out of the actual end material, such as tool steel or aluminum. It always produces a new part or part reconfiguration directly from a CAD drawing.

DMD is the blending of five common technologies: lasers, computer-aided design (CAD), computer-aided manufacturing (CAM), sensors, and powder metallurgy. The resulting process creates parts by focusing an industrial CO_2 laser beam onto a flat tool-steel workpiece or preformed shape to create a molten pool of metal.



- A small stream of powdered tool steel is then injected into the melt pool to increase the size of the molten pool.
- By moving the laser beam back and forth, under CNC control, and tracing out a pattern controlled by a computerized CAD design, the solid metal part is built one layer at a time.

- With this process, the molten pool cools and solidifies rapidly producing metal parts of superior quality and strength with no material waste as in conventional machining.
- The parts have consistent, fine microstructures, with superior quality and tool strength.
- More importantly, with DMD, the metallic composition can be altered by injecting different types of metal powders into the melt pool.

FROM CAD to STEEL

A typical job starts on POM's secure FTP Web site (www.pom.net), where customers post CAD files.

- Engineers download and edit the CAD file, adding machining stock or hard-face surface geometry. The updated solid CAD model is then sliced and tool paths, identical to that used for CNC machining, are generated.
- Information is downloaded to the overhead three-axis gantry machine similar to a CNC setup with travel in the **X, Y** and **Z** axes.
- The process uses a variety of metal powders and metal matrix composite materials, including conventional tool steel alloys and special metals.
- Cooling rates are fast, resulting in a very fine-grain microstructure.
- Hard faces are applied within an inert-atmosphere box, filled with pure argon, that surrounds the workpiece and the machine nozzle.

The Big Three of Manufacturing

DMD for the processing of molds, dies and prototype parts provides is thought be the Big Three of Manufacturing:

- **Speed** - as in faster product to market. A study performed by the National Center of Manufacturing Science indicates die production time can be reduced by 40% with DMD.
- **Economy** - lower tooling costs due to factors including the reduction of labor and capital equipment costs.
- **Quality** - the parts produced are generally .001 in. oversized for a quick clean-up.

The DMD Process

A CNC-controlled overhead gantry is used to control a nozzle and focusing optics associated with a $C0_2$ laser according to CAM tool path data associated with the CAD model geometry. Metallic powder, usually a tool alloy or pure copper, is moved from on-board powder feeders by an inert gas at pre-defined rate to the nozzle. The metallic powder is added to the dynamic melt pool established by a traversing beam energy source.

The result is a 3D deposition of tool steel, identical in shape and geometry to that of the CAD model. As a result the cooling rates associated with the process, the tool steel deposition structure is typical to that of an as-quenched condition.

DMD APPLICATIONS

The DMD process can be used for prototype or production tooling in a variety of industrial applications, including:

- **DIE REPAIR AND REFURBISHMENT** - Downtime costs can mount quickly when a mold or die cracks or becomes worn.The DMD process is the only existing method that can repair, reconfigure or resurface existing parts, molds or dies by adding metal that matches the parent tool.
- **THERMAL MANAGEMENT** - The DMD process provides the ability to produce cooling channels or **CoolMold**™ technology, for injection molding and aluminum die cast cavities.
- **DIRECT METAL PROTOTYPES** - Manufacturing companies can now produce rapid metal prototypes instead of plastic SLA (steriolithography) models. Using DMD, it is possible to make a fully functional prototype directly from the CAD design.
- **SURFACE MODIFICATION AND COATINGS -** DMD can improve wear resistance, corrosion resistance, and heat checking of part surfaces through the deposition of a wear-resistant hard-facing layer.
- **AEROSPACE AND AIRCRAFT COMPONENT REPAIR** - The DMD process is ideally suited for repair work in the aerospace industry, due to the strong metallurgical bond and fine, uniform microstructures it can produce.