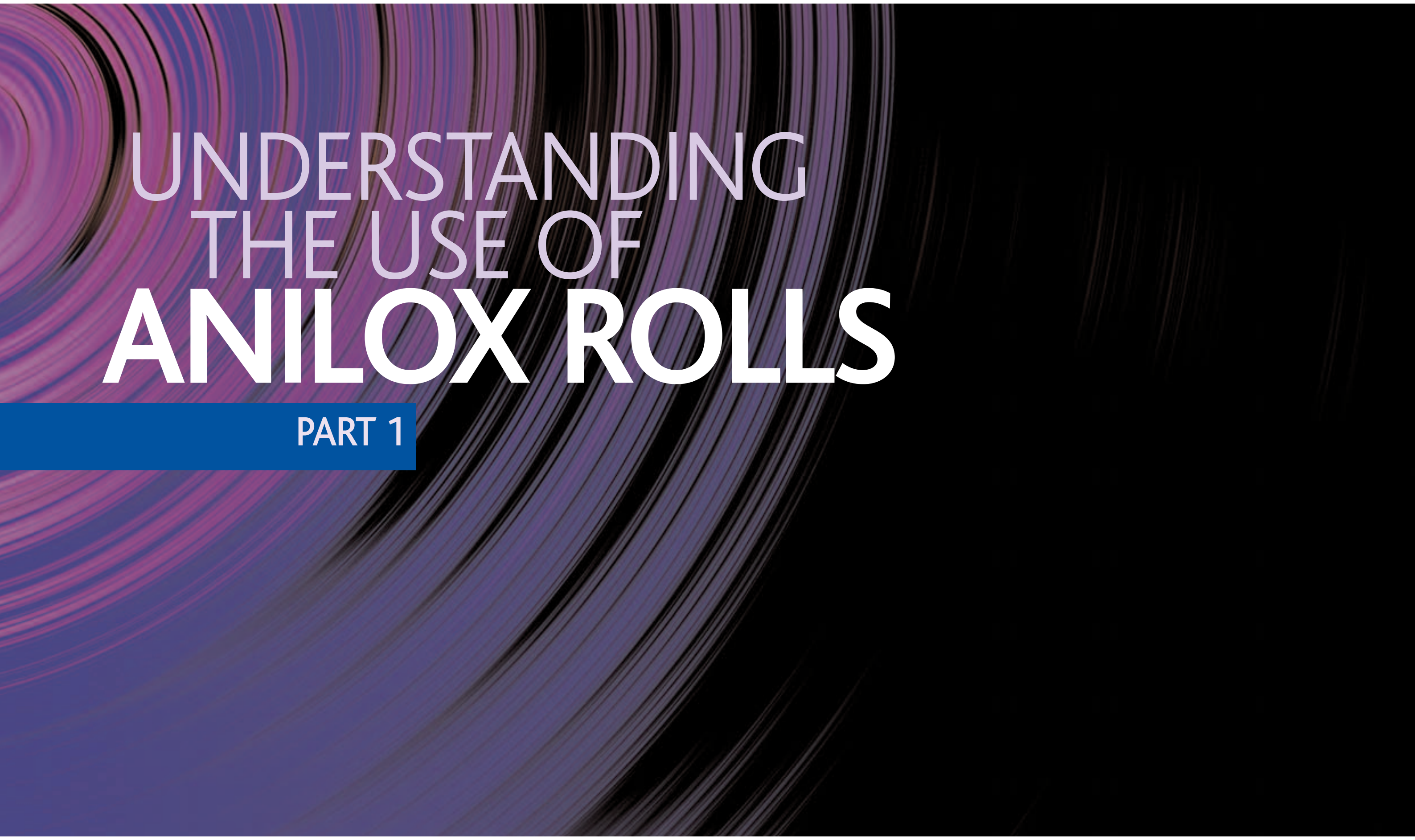
Without adequate knowledge of anilox roll functions, designers can create graphics that are nearly impossible for the press department to produce.

By Brian Jacob, Praxair Surface Technologies, Inc.

UNDERSTANDING THE USE OF ANILOX ROLLS

PART 1



Prior to the introduction of the first laser engraved ceramic anilox roll in 1988, the corrugated industry simply converted flat sheets into boxes for shipping. The laser engraved ceramic anilox roll allowed corrugated manufacturers to reach new levels of achievement by creating boxes that became advertising and selling tools.

This advance gave new importance to the role of designers, as shipping cartons began to emphasize more complex graphics and intricate designs. However, these changes made it imperative for designers to educate themselves about the proper use and abilities of the anilox roll.

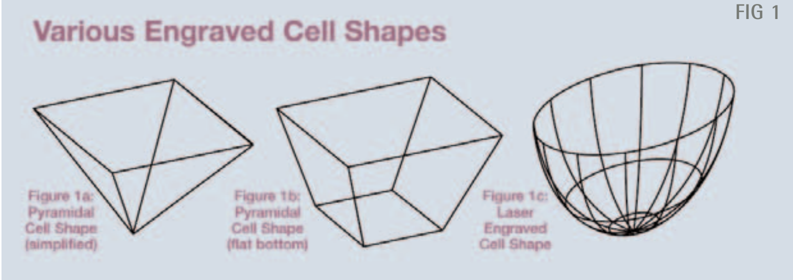
Although it is only one component of the flexographic press, the anilox roll has a huge influence on graphic design. The importance of design became apparent once it was realized that corrugated printers were not producing one box or carton, but rather thousands of boxes that customers expected would be identical.

Although designers have advanced the corrugated flexographic market into areas once never dreamed imaginable, without adequate knowledge of anilox roll functions, designers can create graphics that are nearly impossible for the press department to produce both consistently and profitably.

The initial concept of the anilox roll is simple — a steel cylinder engraved with cells that act as microscopic measuring cups which meter ink to a printing plate. However, without understanding the technological advances surrounding the elements of an anilox roll, it is impossible to make the correct choices for your applications.

Thirty years ago, the only anilox roll choice was a mechanically engraved cylinder. These rolls were manufactured by using a knurling tool to create a pattern on the surface of the roller. Once the knurling process was completed, it was

FIG 1



customary to chrome plate the roller for wear resistance. The individual cells manufactured by this process had a pyramid shape with either a pointed bottom or a truncated bottom. (Fig 1)

Printers soon discovered that the mechanically engraved roll would wear very quickly, in spite of the chrome plating. Thus, the top section of the cell (which provided most of the volume due to its wide opening) would rapidly lose a significant amount of capacity, or volume, resulting in a marked decrease in print density. There are also limitations as to line counts due to the inability to produce smaller knurling tools.

The majority of mechanically engraved rollers will have a maximum line count no greater than 500 lpi. In today's high tech pressroom, with reverse angle and dual chambered doctor blade systems, chrome anilox rolls are virtually impossible to use. In addition, chrome plated anilox rolls typically range between 850-950 on the Vickers scale, which is a measure of hardness. By comparison, the laser engraved ceramic anilox roll will range from 1100-1350 Vickers.

HIGHER CELL COUNTS PER AREA WILL RESULT IN A MORE UNIFORM DISPERSION OF INK ACROSS THE ROLL FACE, THEREBY ACHIEVING HIGHER PRINT QUALITY.

ALL ROLLS ARE NOT ALIKE

It is important for designers to understand that various plasma engraving types definitely affect ink release from an anilox cell. This means that anilox cylinders with identical line counts and volumes, but from different manufacturers, will not be the same. They will release ink in different proportions, which results in varied densities.

It is also essential to understand that the theoretical volume of an anilox roll and the actual transferred volume are never the same. The porosity of the ceramic coating will affect ink release. Thus, variations in porosity will yield variations in density.

Finally, the hardness of the coating will also affect the length of time the roll will run without losing density. Each of these components: volume, porosity and hardness, combined with the quality control of the manufacturer's laser engraving equipment and coating boxes, will affect the performance of an anilox roll. Therefore, it is important to understand that purchasing by price alone is not always the wisest choice. In simple terms — anilox rolls are not a stock commodity.

First, Select A Substrate

The basic anilox cylinder is manufactured of a steel substrate. Although durable, these rollers are heavy and subject to corrosion problems if not properly maintained. To address the corrosion issue, a stainless steel roll base was introduced to the market. Lighter in weight, these rolls are more costly, but offer the advantage of resisting corrosion from edge chips, abrasive ink properties and other elements.

A new technological advance is the composite, or carbon fiber, roll. There are no visible differences between a carbon fiber roll and the conventional steel cylinders, but the similarities end there. Constructed with a carbon fiber composite material, these rollers are 40-60% lighter than their steel counterparts, but have the additional advantages of being stiffer and more stable. However, they are coated with the same durable ceramic coating and capable of being engraved with the same wide range of patterns as the conventional steel laser engraved anilox roll.

Construction of the carbon fiber roll begins with a strong lightweight tube. High strength carbon fiber strands coated with molten high performance resin are wound around a mandrel to form the tube. The strength of the fiber strand material, the angles used for winding, and the wall thickness of the tube are designed to customer specifications to minimize deflection over the length of the tube. After winding, the resin and fiber are cured at high temperatures to produce a rigid lightweight composite tube.

Journals are the next choice. Available in a variety of materials, including carbon fiber, carbon steel, stainless steel or aluminum, once selected, they are mated to the tube by bonding the ends with high strength epoxy formulated for joining composite structures. The method of attaching the journals completely encases the ends of the composite tube wall to protect edges that might otherwise become vulnerable to damage during handling. (Fig 2)

ALTHOUGH IT IS ONLY ONE COMPONENT OF THE FLEXOGRAPHIC PRESS, **THE ANILOX ROLL HAS A HUGE INFLUENCE ON GRAPHIC DESIGN.**

Creating A Ceramic Coating

The hard ceramic coating on an anilox cylinder is created by a plasma torch. (Fig 3) The name is derived from the gas plasma, or ionized gas, created to apply the coating.

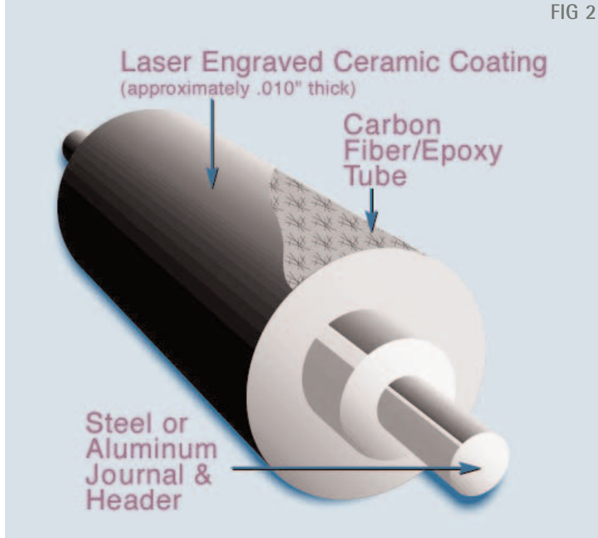
Ni gas flows through the torch to an anode nozzle that is positively charged by a welding power supply. A cathode positioned in the stream near the anode is connected to a negative power supply, creating an electrical arc. The gas flows through this high energy arc and ionizes. The resulting heat causes the gas to expand under high pressure. When the pressure escapes through the nozzle opening, it forms a high velocity stream of hot expanding plasma flame.

Chromium oxide coating powder is injected into the torch to pass through the arc. The core temperature of the plasma flame is approximately 50,000° F. (30,000° C.), which melts the powder, allowing it to adhere to the surface of the roller as it is being rotated in front of the torch.

The thickness of the coating is determined by the rotation speed and the torch movement. This coating provides the corrosion resistant and wear resistant properties so necessary in an anilox cylinder.

Of course, the roll must still be laser engraved, which means the coating must be capable of accepting the engraving process and still maintain its original characteristics and surface integrity. The coating bond strength to the surface of the cylinder should be in excess of 5000 psi (as measured per ASTM C633). This will assure it remains in place under the most demanding application environments.

FIG 2



HIGHER CELL COUNTS PER AREA WILL RESULT IN A MORE UNIFORM DISPERSION OF INK ACROSS THE ROLL FACE, **THEREBY ACHIEVING HIGHER PRINT QUALITY.**

The Importance of Porosity

Designers must also be aware of coating porosity. The lower the porosity, the smoother the coating, thus enabling a more precise engraving. High quality ceramic coatings will have low porosity, non-wetting tendencies with the appropriate surface tension for proper release coefficient.

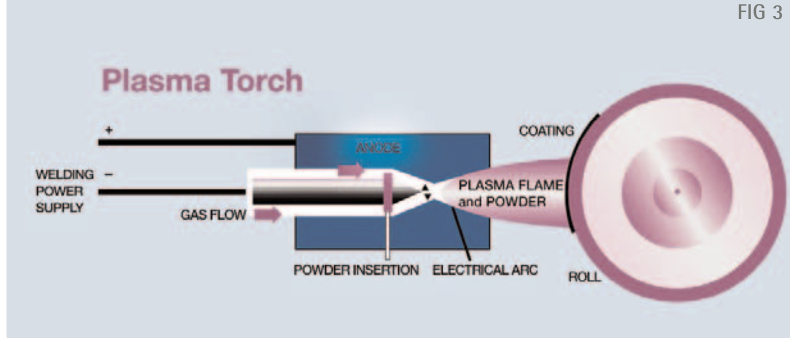
If the manufacturer has high quality coating powder, the roller will release ink readily, will be easier to clean, and will have enhanced resistance to the wide variety of anilox roll cleaning agents available.

Next, Select Your Engraving

Every engraving consists of three main components: angle, lines per inch, and depth, or volume. The combinations available are nearly limitless and the choice made by a designer will depend upon the graphic effect he is hoping to achieve. The type of engraving will also vary based upon the type of laser being used.

Basic engraving styles are created using a CO2 (carbon dioxide) laser. More complex engravings are produced using a YAG (yttrium aluminum garnet) laser. Leading manufacturers in the laser engraved anilox roll industry also offer a variety of finishing techniques for their engravings — each designed to achieve a different effect in the final product.

FIG 3



Laser Engraving

Everyone is familiar with the use of laser technology, particularly in the medical field. However, recent decades have found the use of lasers expanding into fields such as welding, automotive, drilling, etching and printing. The CO2 laser, which is the most common type in use, uses carbon dioxide in combination with helium and nitrogen, to generate pulses of energy — each pulse responsible for producing an impression in the ceramic coating of the roll. As CO2 lasers have improved, the pulse rates have increased, allowing manufacturers to produce rolls quickly and with greater reliability.

In recent years, the use of the YAG laser was introduced. Rather than using gases to create laser energy, the YAG laser uses ceramic crystals of yttrium aluminum garnet, hence the acronym YAG. The YAG laser is considered a solid state laser.

The major differences between the CO2 and YAG laser are the pulse shape and the wave length. Due to the operational properties of the CO2 laser, it produces what laser technicians refer to as a "long decay." This long decay results in lower rotational cell walls, which leads to unwanted channeling. Occasionally, this will result in poor print results. A CO2 laser also has a lower rise time, which causes more recast on the cell walls, creating problems with doctor blade wear and loss of print quality.

By contrast, the solid state laser features a much steeper rise time and a shorter decay, creating cleaner cells with distinct cell walls and symmetrical geometry.

Wave Length

The CO2 laser has a fixed wave length of 10.6 micrometers, or microns, producing energy in the form of invisible light. A solid state laser operates with a wave length of 1.06 microns. The longer wave length of the CO2 laser limits its ability to produce higher line counts due to the mathematical relationship between the wave length of the laser and the smallest possible spot you can focus a laser beam.

Using a CO2 laser, higher line counts are limited to 1000 lpi. Exceeding that range will result in rapidly deteriorating quality. When using a solid state laser, the shorter wave length allows line counts up to 1500 lpi without any difficulties.

Solid state lasers also offer the benefit of improved coupling. This relates to interaction between the laser energy and the coating material. When the laser beam strikes the material, a portion of the energy reflects, while the remaining energy is absorbed into the material. When engraving the chromium oxide of an anilox roll coating, this produces two processes: melting and vaporization of the ceramic coating. The more complete the vaporization, the better the quality of the coating. Customarily, however, a portion of the coating will melt, rather than vaporize. This produces the recast phenomenon. Recast is kept to a minimum when using a solid state laser, which provides maximum vaporization, with little melting, resulting in a uniformly consistent engraving exhibiting very little recast. The outcome is a smoother, higher quality engraving, which reduces doctor blade wear. The ability to engrave deeper creates high cell volume, as well.

> THE ENGRAVING COMBINATIONS AVAILABLE ARE NEARLY LIMITLESS AND THE CHOICE MADE BY A DESIGNER WILL DEPEND UPON THE GRAPHIC EFFECT HE IS HOPING TO ACHIEVE.

An additional benefit is the ability to focus the laser beam onto the ceramic coating using special lenses. The process is comparable to focusing a microscope, camera or loupe. Achieving a consistent engraving across the entire roll face requires a constant focusing distance. The margin within which this focusing distance may vary without changing the engraving is referred to as a "sweet spot."

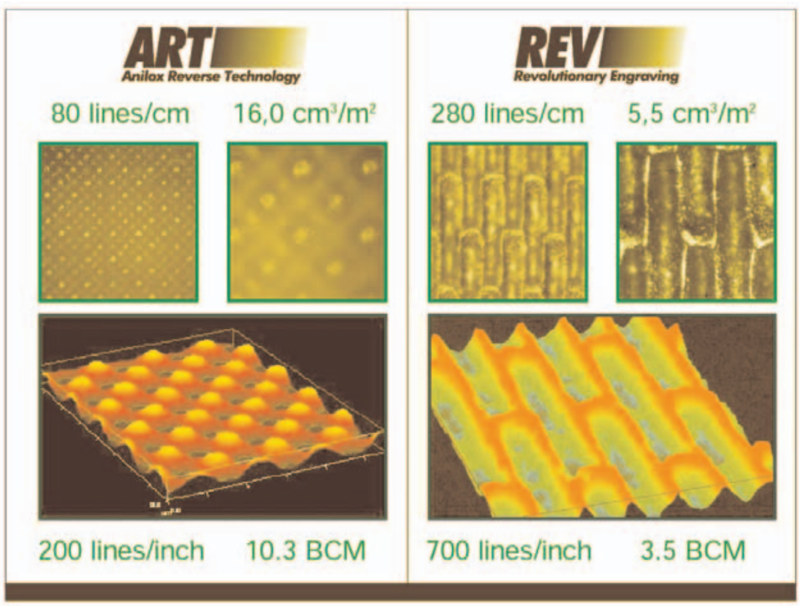
Newer solid state lasers have larger sweet spots than CO2 lasers, making them capable of producing engravings with few variations due to taper and TIR (Total Indicated Runout — a measurement of the concentricity of a roll). It is virtually impossible to manufacture a roller without some minute amount of taper and TIR. With the use of a CO2 laser, this variance could cause engraving differences at opposite ends of the roll. Due to the larger sweet spot of the solid state laser, this effect is almost completely eliminated.

Standard Engraving Patterns

The original laser engraved ceramic anilox rolls relied initially on engravings with a screen angle of

45°, partly because this was the angle typically used in creating the mechanically engraved cylinder, and customers were familiar with the capabilities of a 45° angle roller. As the industry evolved, however, more screen angles were introduced to anilox roll users, particularly 30° and 60° angles, which enabled the engraver to increase cell count by 15% over a given area compared to the 45° patterned roll.

It is important to remember that higher cell counts per area will result in a more uniform dispersion of ink across the roll face, thereby achieving higher print quality. For applications requiring higher viscosity, radiation or UV-cured inks, 30° angle engravings tend to reduce anilox "spitting," especially if the cells are slightly channeled.



The 60° angle has become the most popular pattern of choice today, primarily because it enables close hexagonally packed cells, the ideal way to include the most cells in a given area. These 60° angles have the added advantage of being very compatible with today's doctor blade technology. They mate well with all types of doctor blades and require a very minimal break-in period.

Selecting an engraving with a 60° angle will give you high quality graphics in any number of applications. Designers choosing this engraving angle will be very satisfied with the results.

IN TODAY'S HIGH TECH PRESSROOM, WITH REVERSE ANGLE AND DUAL CHAMBERED DOCTOR BLADE SYSTEMS, CHROME ANILOX ROLLS ARE VIRTUALLY IMPOSSIBLE TO USE.

Advanced Engravings

Technological improvements have developed radical new screen patterns for the designer to consider. One example is advanced helical and tri-helical cell wall engravings. Although created using conventional laser technology, these engravings have a unique appearance, which differs from standard anilox engravings due to the very unusual cell configuration.

A raised surface, or post, is created between the cells. This post supports the doctor blade, allowing the smooth surface of the engraving to provide a superior laydown. Over two years in development, this design now offers the designer higher density for the same amount of product being transferred versus conventional engravings.

Pin holing problems are virtually eliminated as a result of the exceptional release qualities of these engravings. In addition, cleanup is easier, due to the open channel geometry of the cells. Traditional engravings tend to trap ink, adhesive, or varnish in the deep enclosed cell bottoms. (Fig 4)

Another newer design offers a 90° spiral, or helical, groove around the circumference of the cylinder, creating a ridge to support the doctor blade. This engraving process offers higher densities, improved ink transfer, easier cleaning, and exceptional solid coverage. Created using either a CO2 or YAG laser, the smooth surface of the roller exhibits no cells (as we know them), resulting in improved doctor blade wiping action. This remarkably smooth surface also reduces doctor blade vibration, improving print quality.

Part 2 of this article will appear in the March/April issue of Corrugated Today and will cover how to choose an anilox roll along with proper care and cleaning.

Brian Jacob began his career in 1977 with Pamarco. In 2004 he formed a sales consultancy company, Jacob Corrugated Services, and has been representing Praxair since its inception. He can be reached by e-mail at brianjacob@earthlink.net. Praxair is based in Charlotte, N.C. For more information, visit www.praxair.com/printing.