Right Blade/Right Roll/How to Tell?

It's Not Easy!

By Paul Sharkey

As the quality of the flexographic printed image has improved, many key process elements have become more complex. One of the most important of these evolved process elements relates to ink transfer--the process of metering and transferring the correct amount of ink from the anilox roll's surface to the image carrier and ultimately to the substrate. Technical gains in this critical process area have, perhaps more than any other, enabled flexography to achieve its current stature.

While many pressrooms have kept up with the technical evolution of anilox rolls, a surprising number have not taken advantage of the significant advancements in doctor blade technology. They continue to run the same blade today that they ran 15 years ago in an entirely different process environment.

Why? Aside from price and supplier performance claims, it's not easy to "see" the differences that exist from one blade to the next. On top of that, it's a challenge for pressroom managers to sort through the many doctor blade choices offered by so many doctor blade suppliers. Understandably it's easier to stay with what they know or think they know.

Finding the doctor blade most compatible with today's technically advanced anilox roll surface can be challenging. To understand where blade technology is today, it helps to understand what has driven the changes that have occurred.

HISTORICAL PERSPECTIVE

As recently as the 1970s, excess ink was metered or removed from an anilox roll's engraved- and chrome-plated surface using a rubber metering or wipe roller. At that point in flexo's evolution, anilox line counts ranged from 160 to 360 cells per inch. (360 was the maximum possible for mechanical engraving). At the time, most flexo printing consisted of solids, reverses, large type and some screens. When process print was attempted, it was coarse and looked best from across the grocer's isle.

Fine screens and process print were not possible because anilox ink films were too thick. Rubber roll metering further compounded the problem because the rolls were hydraulically sensitive to speed. As speed increased, ink pushed the rubber roll away from the anilox, making the ink film even thicker.

In an attempt to meter ink more consistently, some flexo presses were modified to replace the rubber wipe roll with a steel doctor blade. While this move improved metering, blade materials available at the time were coarsely structured strip steel. They were very wearing to the engraved- and chrome-plated surface. And, the mechanical engraving process was still limited to a maximum anilox line count of 360, meaning the surface ink film was still thick.

In 1981, everything changed with the introduction by Praxair Surface Technologies of laser-engraved ceramic anilox rolls. While this new surface was first introduced because of its durability, the real advantage quickly became apparent.

It became possible to "burn" a much higher line anilox surface; one better able to be tightly metered to achieve a thinner ink film. Ink could be transferred under more control from more cells that were deeper with wider openings. Reduced anilox surface ink films made it possible to print fine process dots for longer periods with less dot gain.

Fast forward to 2011..The ink transfer process changes described did not happen overnight, nor did they happen alone. Every flexographic process element changed in step with one another to bring flexography to this moment when print quality and production efficiency is as formidable as that of litho-offset and rotogravure.

IDEAL ANILOX ROLL

Today, an ideal anilox roll / sleeve meets very specific verifiable tolerance specifications. The following are major points to consider when establishing specs:

- Dimensionally, the entire roller must be perfect, or as close to perfect, as possible.
- The ceramic's hardness and density needs to be consistent across and around the roll.
- Cell dimensions (opening, depth and wall thickness) must be within agreed tolerances and uniform across the surface.
- Post laser-engraving polishing to reduce surface friction is essential. The more the better. Don't be afraid to ask for a wider, flatter wall.
- Know how the surface is protected, over time from subsurface corrosion.

Bottom line, the performance of an anilox roll speaks for itself in terms of ink transfer and wear-ability.

Best Blades

For most flexo printers an ideal doctor blade is one that:

- Meters an anilox surface uniformly and precisely.
- Wears slowly and uniformly.
- Produces minimum and uniform sized debris as it wears.
- Produces the lowest amount of friction against the anilox roll's surface.
- When needed, can last long enough to finish a job without stopping.
- Is made from highly refined strip steel.
- Its chemistry reduces wear without increasing hardness.

But what about doctor blades…how can a pressroom select the doctor blade most compatible with today's technically advanced anilox roll surfaces? What factors should be considered to assure precise efficient metering? To answer these questions, we must understand the fundamentals of ink transfer, especially as it relates to minimizing the anilox ink film.

The core purpose of a doctor blade is to remove excess ink from an anilox roll's surface. The following are the basic rules of engagement between a doctor blade and an anilox roll surface.

- First, the **contact area** between the blade and anilox roll surface should be kept to a minimum. It results in less wear to the anilox surface and reduces hydraulic push back of ink, thereby making a thin ink film possible.
- Next, the doctor blade material should **not harm the anilox roll** by contributing to unnecessary wear or by causing score lines in the anilox surface.

While these two points are simple enough to understand, achieving them has always been a challenge.

When it comes to achieving minimum blade to anilox roll contact area, the actual blade contact area is determined by the following factors:

- **Blade edge** at contact point is determined by edge type. *See Figure 1*.
- **Thickness** of the doctor blade material.

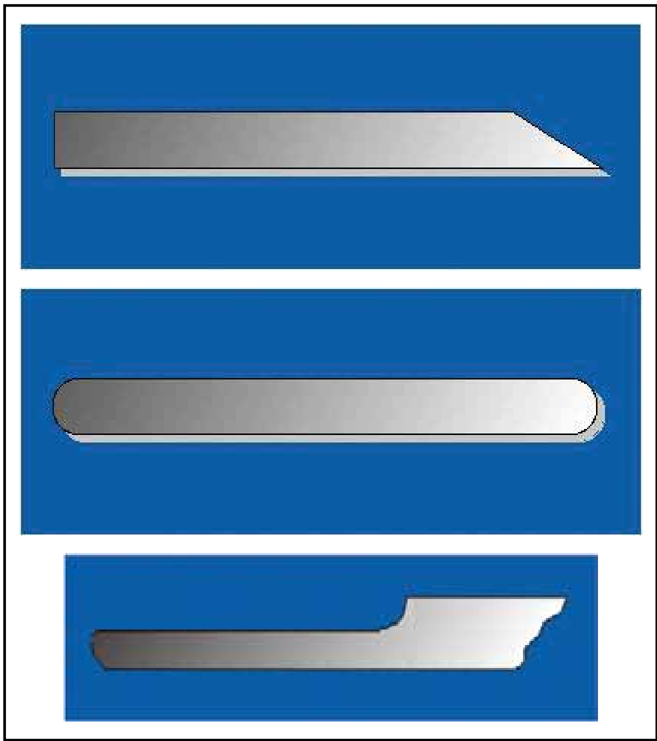

Figure 1: From Top, Bevel, Radius and Lamella edge types

Figure 2: Edge slivering.

- In order to form a more perfect seal, pressure must be maintained between the chamber and anilox roll during a pressrun.
- Under pressure, thinner blades flex, causing a wider contact area and edge slivering. See *Figure 2 and Figure 3*.
- Thicker blades (.008 in. / .010 in.) flex less than .006 in.
- **Pre-set angle** as determined by the blade holder
  - Ideal is 30 degrees – 35 degrees (*Figure 4*).

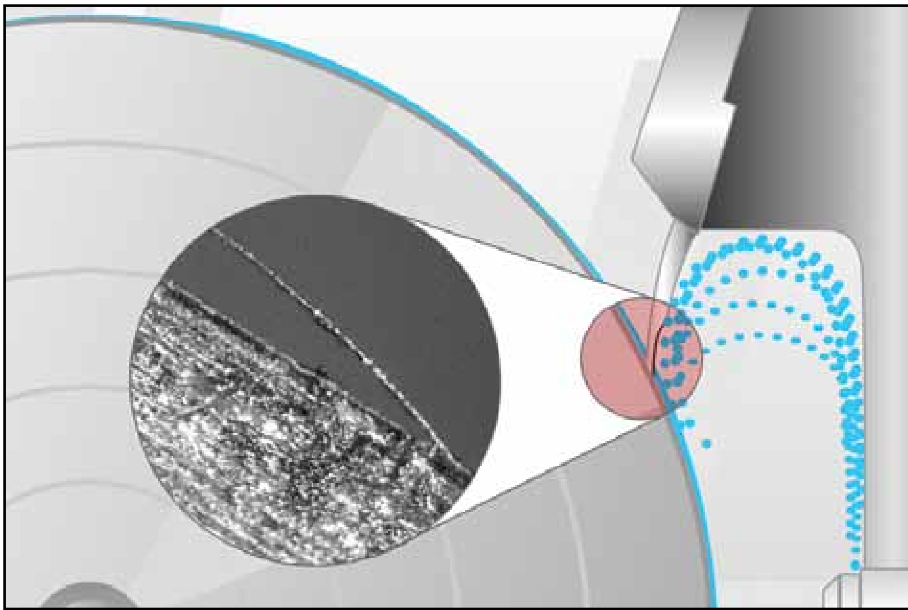

Figure 3: Excess chamber-to-anilox roll pressure increases contact area and ink film. It produces edge slivering.

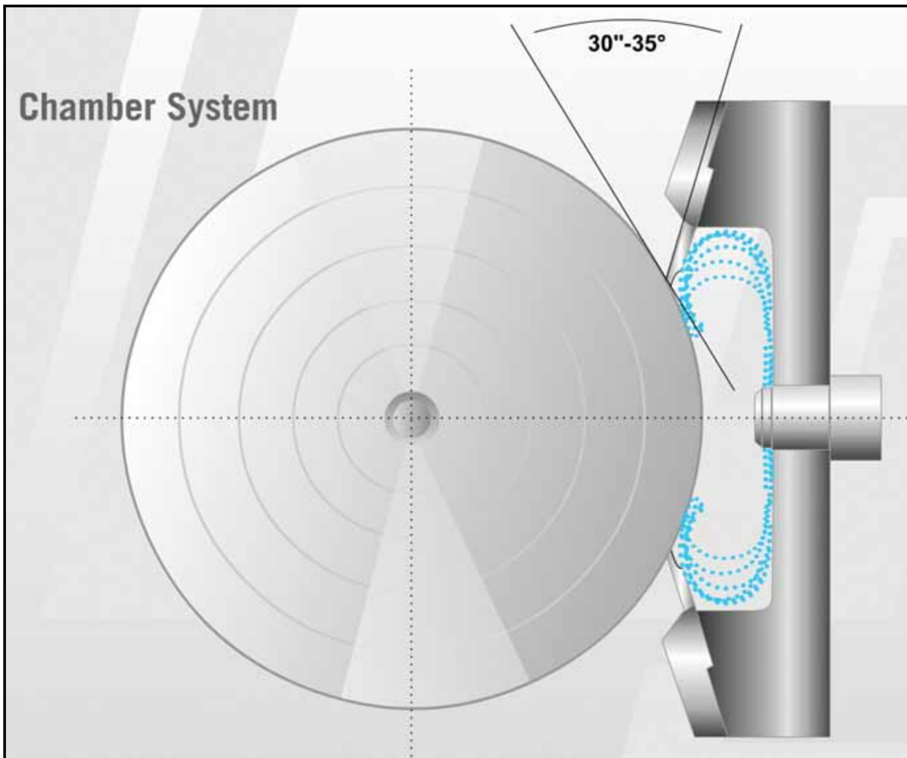

Figure 4: Ideal doctor blade set angle for Flexo.

STEEL VS. PLASTIC

As discussed, a thin contact area will better meter ink and minimize the anilox ink film. Further, the rigidity of a .008 in. or .010 in. thick blade will resist flex better, resulting in less contact. In order to achieve the same rigidity value of steel, plastic blades must be three-to-five times thicker than steel. As a result, plastic blades have much greater contact areas, resulting in a much thicker anilox ink film. Simply said, plastic blades cannot meter as tightly as steel blades, making steel the better metering choice for all controlled ink transfer applications.

Myth Buster…Some printers mistakenly think plastic blades are less likely to wear or damage an anilox roll's surface and are safer to handle than steel blades. In addition to not metering as precisely as steel, the edge of a plastic blade heats up and softens. Hard resin and hard pigment particles can lodge in the soft plastic edge (See *Figure 5*) and ride on the anilox roll's surface. The hard particles can knock down cell walls. In addition, polymers from the blade can embed into the ceramic causing cell fill-in. These polymers can be very difficult to clean from an anilox roll. When it comes to safety concerns, used plastic blades can be just as cutting as steel and require the same safety precautions when handling.

PERFORMANCE ENGINEERED

Although plastic blades and composite blades are used for some printing with lower line counts, e.g. some types of corrugated boxes and laminating, steel is by far the most

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common type of blade material used for ink-metering doctor blades. Strip steel is the type of steel from which doctor blades are made.

Figure 5: Resin embedded in plastic blade edge.

There are many different types of strip steels available for use in hundreds of different industrial applications. Strip steels are used for flapper valves, numerous automotive applications, razor blades and of course doctor blades. Because each application for strip steel often has different and diverse performance requirements such as durability, ductility, malleability, corrosion resistance, wear resistance, memory, and so on; strip steels can be very different from one another.

When doctor blades were first introduced to flexo printing 40 years ago, the strip steels selected for doctor blade use were inexpensive and usually better suited for general industrial applications. However, advancements in anilox roll technology made those steels less suitable for precision metering.

Today's advanced doctor blade strip steel is a precision-made material, both in microstructure, hardness and in execution. Requirements on steel producers are quite stringent, targeting at tensile strengths of about 2000 N/mm^2, Vickers hardness of about 600, a fraction of a millimeter deviation per meter in straightness, polished surfaces, smooth shaved edges and fine-grained microstructure.

Different ingredients (chemistry) and customized treatments, combined with specifically tailored edge treatments, mean a doctor blade can be custom engineered for maximum performance in different flexo applications. *Figures 6 and 7* illustrate coarser-grained and finer-grained doctor blade steel microstructure.

Figure 6: Coarser-grained microstructure.

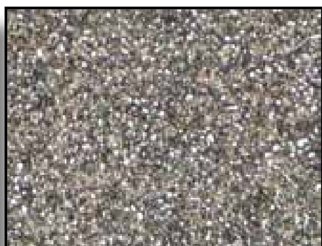

Figure 7: Finer-grained microstructure.

The typically less expensive coarser-grained microstructure contains a number of rather large carbides unevenly distributed, which decrease the ductility of the steel, providing sites for crack initiation and chipping. A typical blade wear surface for coarser-grained microstructure showing anilox lines and chipping is shown in *Figure 8*.

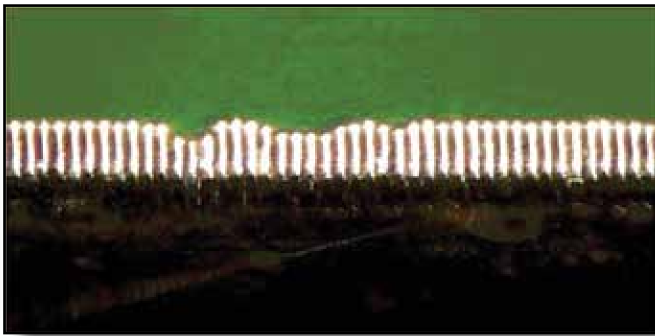

Figure 8: Coarser grained doctor blade surface wear showing anilox lines and chipping.

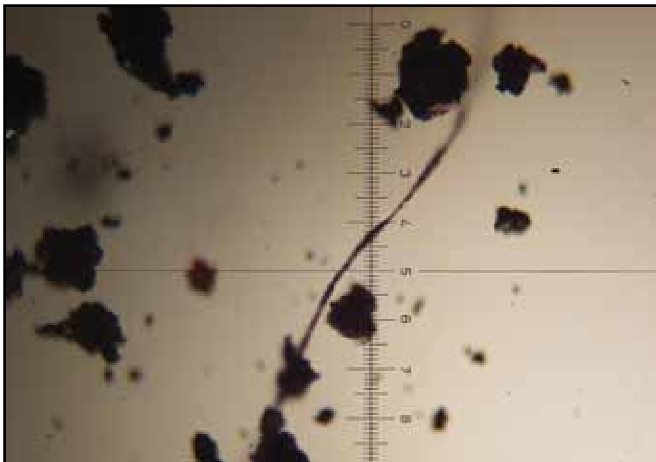

Figure 9: Debris from coarse strip steel collected by on-press 50 μ filter bag.

Figure 9 depicts the debris field, as collected on press. Conversely a finer-grained microstructure contains a larger number of smaller and more evenly-distributed carbides. The advantages of this high definition steel can be seen in *Figure 10*.

Advantages of fine-grained steels are:

- Uniform, clean wear and thus a lower wear rate.
- Less formation of slivers.
- Lower friction and scoring damage to the anilox roll surface.

Collectively, those traits result in 1) lower blade consumption, 2) less damage to the anilox roll, 3) less production downtime and fewer stops, 4) a better print result.

WHAT'S NEXT

For the finest of print images, a customized and coated steel doctor blade is often preferred. These new tips ensure close wiping of the anilox roll for a clear print, while the coating lubricates to decrease friction and wear on the blade. The coating is harder and less ductile than the underlying steel, increasing resistance to hard ink pigments and reducing the tendency to sliver formation and particle-sticking.

There are several types of coated blades available on the market, using tribological materials of varying thicknesses. *Figure 11* shows one example of a coated doctor blade tip. The development of nanotechnology will likely enable a

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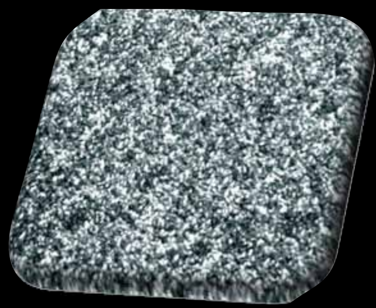
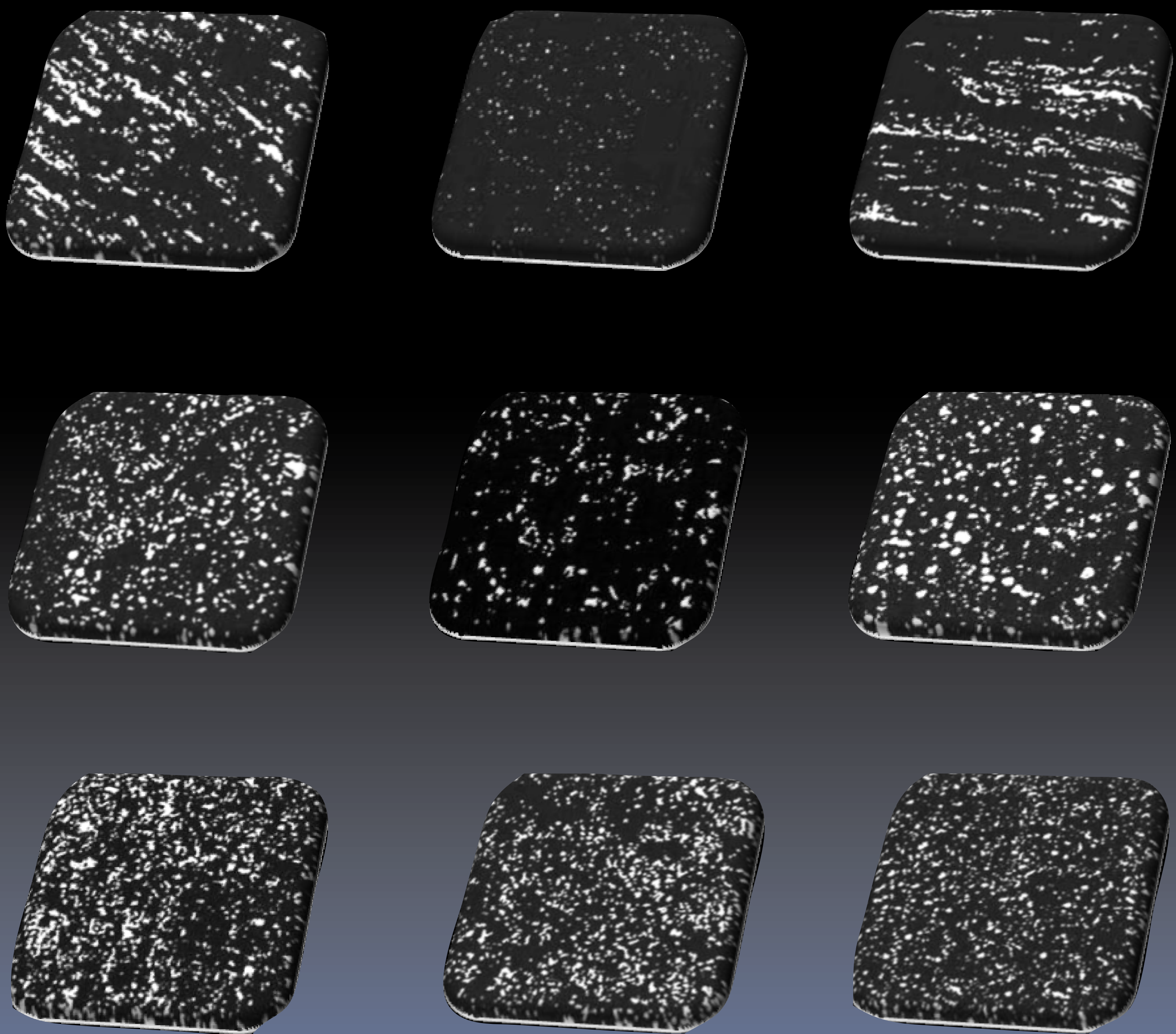
Steel Microstructure Matters

Even distribution of consistently small particulate assures slow even edge wear, less friction and smooth ink film formation.





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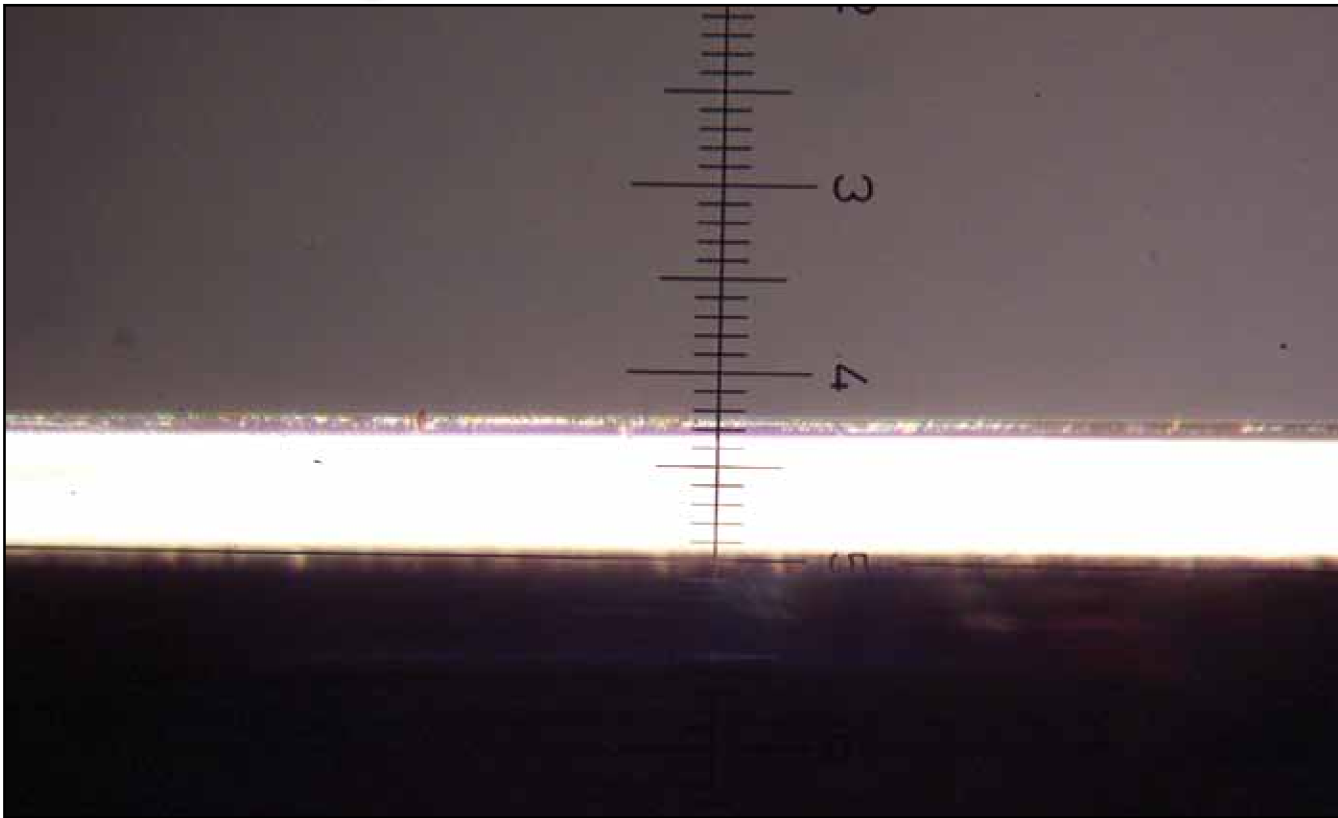


Figure 10: Worn edge of doctor blade made from fine grained strip steel.

greater variety of coatings in coming years.

Choose a doctor blade partner, not just a blade…Considering the achievement of the flexographic process over the past 30 years, there are more diverse applications than ever, often in the same pressroom. Just consider the following:

Figure 11: Coated doctor blade tip.

- 150 lpi screens.
- Solvent based inks.
- 1200 lpi anilox rolls.
- 1,000 fpm press speeds.
- Solid opaque white, water based ink.
- 250 line count anilox rolls.
- UV ink and coating.

Fortunately, doctor blades have been developed to meet each of these challenges. There are blades that don't corrode in hostile environments, are able to run for extended periods at high speed, can run on multiple jobs and can prevent UV spitting.

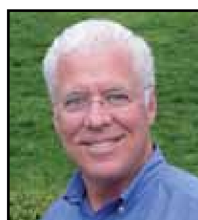
By selecting a knowledgeable doctor blade partner, one that offers the latest strip steel and blade technology and takes an open consultative approach, a printer can avoid costly missteps.

An ideal doctor blade partner is one who:

- Offers a wide range of new materials better able to meet sustainability objectives.
- Conducts pressroom assessment audits to determine application needs.
- Offers used doctor blade evaluation reports.
- Offers specific doctor blade recommendations.
- Is willing to conduct blade evaluation trials.
- Assists with operator doctor blade optimization training.
- Helps printers to optimize their production process.

Conclusion… The good news for today's flexo printer is, "You are not alone." There are a number of qualified doctor blade suppliers that offer the technical support necessary to match the right doctor blade to each type of anilox roll available. ■

About the Author: *Paul Sharkey is the founder of FLXON Inc. and has worked in the flexographic printing industry for more than 35 years, primarily in the areas of anilox rolls, ink transfer and ink management.*



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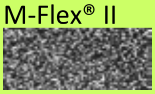
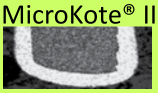
Product Series / Name	Product Description	Gauge Range	Industry Segment	Product Application / Performance Features
300 M-Flex® I  microstructure	Carbon Steel Blade High Density Refined Microstructure	**Width:** .27" - 3.15" 7.0 mm - 80.0 mm **Thickness:** .003" - .015" 1.076 mm - 0.38 mm	Flexo Gravure	excellent wear resistance + uniform edge wear in a variety of flexographic and rotogravure applications. Suitable for use in water, solvent, UV and EB inks and coatings
400 MicroNox® I  microstructure	Stainless Steel Blade High Corrosion Resistance	**Width:** .39" - 2.38" 10.0 mm - 60.0 mm **Thickness:** .003" - .015" 1.078 mm - 0.38 mm	Flexo Gravure	Excellent corrosion resistance, uniform wear in both flexographic and rotogravure applications
500 MicroNox®II  microstructure	Alloyed Steel Blade High Corrosion and Wear Resistant	**Width:** .39" - 2.36" 10.0 mm - 60.0 mm **Thickness:** .004" - .008" 0.10 mm - 0.20 mm	Flexo Gravure	Corrosion and wear resistant alloyed steel, more refined, lower friction, slow wear on whites
600 M-Flex® II  microstructure	Carbon Steel Blade High Density Ultra Refined Microstructure	**Width:** .39" - 2.76" 10.0 mm - 70.0 mm **Thickness:** .006" - .008" .015 mm - .020 mm	Flexo Gravure	HD - Higher Definition micro-structure provides slower and more uniform edge wear in all print applications
600 P M-Flex® Plus  microstructure	Carbon Steel Blade Specially Alloyed and purified for extra wear resistance and ductility	**Width:** .39" - 2.36" 10.0 mm - 60.0 mm **Thickness:** .006" - .008" 0.15 mm - 0.20 mm	Flexo Gravure	Enhanced HD Performance steel for precise, low impact, precision metering on all anilox line counts over extended runs. Excellent for line, process and vignettes.
700 G MicroKote®  microstructure	Micro Carbon Steel Blade Proprietary Ultra-durable long-life coating	**Width:** .78" - 2.78" 20.0 mm - 70.0 mm **Thickness:** .006" - .015" .015 mm - .038 mm	Gravure	ink repellent coating + enhanced tip provides precise metering over extended runs or multiple jobs. Lower friction.
700 X MicroKote® X  microstructure	600P Material with Ultra-durable long-life coating	**Width:** .39" - 2.36" 10.0 mm - 60.0 mm **Thickness:** .006" - .008" 0.15 mm - 0.20 mm	Gravure	Combination of 600P base material plus MicroKote® coating.
800 MicroKote® II  microstructure	Micro Stainless Steel Blade with Ultra-durable long-life coating	**Width:** .39" - 2.36" 10.0 mm - 60.0 mm **Thickness:** .006" - .012" 0.15 mm - 0.20 mm	Gravure	The 800 series give you all the performance features of the 500 series along with the patented MicroKote® coating

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