The Pads of Pad Printing

Pads have changed significantly since the invention of the process over 100 years ago. Initially inflated animal organs were used as pads. Later gelatins were used in an effort to make pads more durable. It wasn't until the late 1960s that the modern silicone pad was invented in Germany.

Pads are a formulation of a liquid base material, silicone oil, and a catalyst. The base material makes up the mass of the pad. The amount of oil added to the base determines the hardness (or durometer), and the catalyst allows the pad to set-up in its mold. The color of the pad can be from either the base material, or the catalyst. Most pads are reddish-brown in color, but there are also blue, white, yellow, green, gray, red and clear pads.

Pads vary in quality depending upon the base material. Cost is usually directly proportional to the quality of material and the volume of the mold. Bases can be made from wood, aluminum, steel or plastic.

Pad manufacturers can have anywhere from a few dozen to a hundred or more "standard" pad molds. The mold determines the size, shape and texture, and the formulation determines quality, color and hardness of the finished pad. Most standard pad shapes are variations of four basic shapes: cone, roof-top, rectangular and square. Your supplier should have a standard pad to fit the majority of applications you'll encounter. Most printers have a selection of half a dozen or so pads in varying durometers that they use for 80% of their printing. In the event that a standard pad can't do the job a custom pad can be made. Depending upon who your supplier is, having a custom mold built can be a costly and time-consuming process. Some suppliers simply don't want to design, build, pour and store custom molds and pads, while others will do whatever is necessary for you to get the job done. In any event, most people steer clear of custom pads except as a last resort.

Size, shape and hardness are the most important considerations in choosing a pad for any given application. Let's discuss how each of these three variables can affect the final result.

Size

The size of the image to be printed and the size of the machine determine how large a pad you'll want to use. The image, measured diagonally, should not exceed 80% of the length, width or diagonal dimensions of the pad. Anything outside of this recommendation may end up distorted in image pick-up and/or transfer.

Some textures can't be **filled** regardless of how **hard** and/or **steep** a pad you use. To use an analogy, it is like trying to paint a cinderblock wall with a roller.

By **John Kaverman,** *National Sales Manager,* Innovative Marking

The size of machine and cliché are also important. The machine must be able to efficiently compress the pad far enough to pick-up and transfer the entire image. Also, it must be able to do so without interfering with any parts or the cliché holder, the doctoring assembly or ink cup, and without rolling over the edge of the cliché. Also, remember that a pad of the same size, but harder, will require more energy to compress. The same must be considered when choosing pads for multiple color machines.

"Ink-less Compression Test"

You can do a quick test to determine if your compression is sufficient without ink, using only the pad(s) and any cliché:

1. Put your pad(s) in the machine.
2. Put a thin layer of light oil on the image area of the cliché.
3. Place paper where your image will print (preferably over the actual part that will be printed.)
4. Cycle the machine once, allowing it to pick up the oil and transfer it to the paper.
5. Measure the area(s) that the pad(s) picked up and printed to see if they are sufficient. If not, adjust compression setting(s) as necessary, and try again.

If you can't pick up and transfer a large enough area then you'll have to use a smaller or softer pad(s), reduce the size of your image(s), or use a bigger machine.

Shape

The shape of the part is the main factor in determining the shape of the pad. The pad should have a rolling action as it is compressed over the surface of the cliché and the part. The roll starts at the point (or ridge) and travels outward, pushing the air out of the way as it goes. In theory you want to be able to pick up and transfer the image without ever creating a zero degree angle between the pad and the surface onto which it is being compressed.

That means you want a pad steep enough so that it will compress far enough to pick up and print the entire image without trapping air. Basically, the steeper the angle and the greater the mass of the pad, the better. This is especially evident when printing textures.

Compression plays an important roll. Too much compression and you can reach a zero degree angle no matter what the angle of the pad. A fundamental rule to remember in setting pad compression on both the cliché and the part is this: *Use the minimum amount necessary to pick up and transfer the entire image.*

Figure 1 shows normal and over-compression. In both illustrations Dimension A is the angle, and Dimension B is the image width (or diameter). In normal compression the angle (A) is still high when the pad is compressed far enough to pick up the image (B). In over-compressing the same pad to pick up the larger image (B), the angle (A) is now lower, increasing the chance of trapping air.

Pad Location

The location of the image on the pad is very important. In compression the point may trap air. For this reason it is recommended that you avoid placing the point of the pad directly in the image unless you absolutely have to. Move the point far enough away from the image so that it won't create a problem when compressed. If you can't change the location of the pad due to some mechanical limitation, change the location of the image on the cliché.

Cone Pads

Cone shaped pads are, perhaps, the most versatile for printing on a wide variety of shapes. Rolling at the same angle 360 degrees from their tip, cone shaped pads offer excellent consistency when printing flat and/or textured surfaces. Cone shaped pads are often used to print on spherical objects.

In some applications it is necessary to hollow out the inside of cone shaped pads to allow them to be compressed further around a sphere. One example is the balls you see in toy stores printed with cartoon characters. By using a special cone pad which is inflated during image pick-up and deflated during image transfer, the image can be wrapped 180 degrees on the ball.

Another variation of basic cone shape is the "dough-nut" pad. Used to print things like oven knobs, these pads have relieved tips that allow the pad to compress without interference from the raised areas of the knob. **Figure 2** shows two commonly shaped cone pads, and two "doughnut" pads.

Roof-top Pads

Roof-top shaped pads are especially useful for printing images on flat surfaces in cases where the image has straight lines, or blocks of text. Roof-top pads compress in

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opposite directions from their center ridge. Placing the ridge between lines or blocks of text allows the image to be transferred without trapping air. Roof-top pads are also very useful for rolling images from a flat surface up or down onto an angled surface. (I've found that it is easier to roll an image up than down, since it requires less compression.)

Roof-top pads aren't limited to being straight down the center. The ridge can be off center, allowing the pad to compress at different angles on each side when necessary. *Figure 3* shows two standard rooftop shapes and one "off center" rooftop pad.

Rectangular Pads

Rectangular shaped pads usually have a higher angle of compression along their short axis. These pads work well for printing oblong images that cannot be printed with cone shaped pads, and for printing on a radius.

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rectangular pad. Most square pads are solid, since compressing a hollowed out square pad usually results in the image distorting inward towards its center.

Positive and Negative Draft

Very few pads have sides that are 90 degrees to their base or printing surface. Most standard pads have what is referred to as a "positive draft". That means that they are wider at their base with the side walls angled in toward the printing surface. When pads having a positive draft are compressed the side walls bulge outward, which is fine for most applications. When printing

which for lack of a better definition are types of scales used for quantifying hardness.

A pad's hardness comes into play for three main reasons. Two pads of the exact same shape having different hardness will require different amounts of energy to compress the same distance. So hardness is a consideration in choosing size.

Second, the composition of the pad is important in considering hardness. A hard pad would crush a fragile part like a light bulb.

Third, the texture of the surface you're printing on is very important. Hard pads do a better job of printing textures than soft

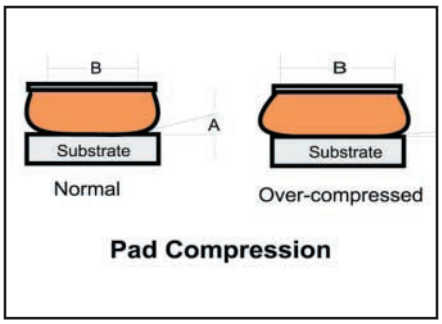

Figure 1

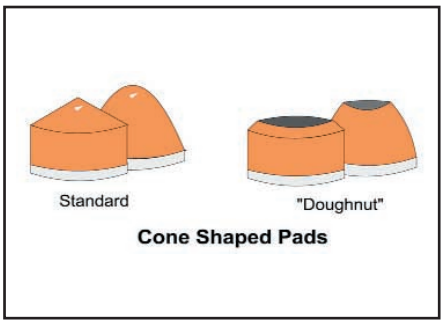

Figure 2

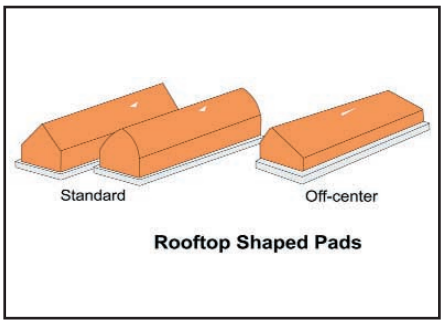

Figure 3

Hollow rectangular pads are useful for applications where you need to be able to compress a long way to pick up a wide image with a machine that can't compress a solid pad having the same surface area. Hollow rectangular pads are also commonly used to print on a radius.

Rectangular pads don't always have two tapers. Sometimes their angle is a single radius. These pads are useful for printing on a radius, but are difficult to use on flat surfaces since they tend to trap air easily. *Figure 4* shows standard and radius angle rectangular pads.

Square Pads

Square pads can be used for many of the same applications as cone and rectangular pads. They're useful when a radial compression pattern won't work because of distortion, and when the image doesn't require the long, low angle of a

down into a recessed area (or next to a perpendicular plane) a pad having a negative draft is sometimes necessary. With negative draft a pad can be compressed without its side walls interfering with the walls of the recess. *Figure 5* shows a pad having a negative draft.

Rotary Pads

Rotary pads are normally completely round, solid pads. In cases where polymer clichés are used, they are notched to avoid compressing on the clamps that hold the cliché on the drum. Finally, they can be a series of individual pads simply mounted to a drum. **Figure 6** shows these three basic rotary pads.

Hardness

Hardness is the last of the three main considerations in choosing a pad. Hardness is also referred to as "shore" or "durometer,"

pads. To most people this comes as a surprise, but it is true.

Soft pads tend to transfer the ink to the peaks of a texture without getting into the valleys. When this happens, air is sometimes trapped in the valleys, later escaping to create pinholes. Plus, since the ink suspended between the peaks isn't sticking to anything, it is less resistant to abrasion. Hard pads get further down into the texture before they transfer the ink.

Printing Textured Surfaces

Some textures can't be filled regardless of how hard and/or steep a pad you use. Many textures are simply too deep, or have too fine a grain to be covered even if you print several times over. In most cases if you get pinholes on the first print you can't fill the pinhole in on successive passes.

Unfortunately, most plastic injection mold designers have no knowledge of this

phenomenon, and they continue to specify difficult textures. As a result, we pad printers get stuck trying to print it later on. To use an analogy, it is like trying to paint a cinderblock wall with a roller.

The alternatives are limited. One option is educating the molder, who in turn can educate his mold makers and designers. Getting a mold changed after the fact usually isn't an option, and de-bossing the print area isn't usually cosmetically pleasing in the end result. If the print has to be absolutely pinhole free about the only thing you can do is bridge the texture intentionally.

You can sometimes bridge with multiple passes by adding air blowers. Directing the air at the part dries the ink between passes, which can increase transfer efficiency. Tacking the ink off a bit more once it is on the pad by adding air there, or by slowing the machine down can also help. Consistently bridging any texture is difficult for even a skilled technician.

The safest approach for the pad printer is to obtain samples of the texture prior to agreeing to run production, then test printing them to determine if the desired print quality is obtainable.

Pad Color and Texture

The color of the pad is rarely an issue. Different silicone manufacturers use different colors to denote quality. I recommend buying pads made from the highest quality material your supplier has in order to get the best performance possible, regardless of what color it is. If color is important to you shop around to find the supplier with the best quality material in the color you want.

Pad textures vary depending upon how smooth the mold that was used to make it is. In most cases differences in the texture of the pad don't adversely affect the print. However, there are those people who prefer the smoothest possible finish for printing on things like the windows quality, the aggressiveness of the inks and solvents, the amount of compression it receives, the type of etch the cliché has, the material you're printing on and how well it is taken care of. Some pads wear out in 200 impressions, others last hundreds of thousands of impressions. There is no magic number, only recommendations:

1. Pads should be stored on their base away from direct sunlight and excessive heat or cold.
2. Pads should never be stacked on top of one another. Stacking can cause flat spots in the pad.
3 Keep pads clean. Don't store a pad with ink left on the surface. Avoid cleaning pads with solvents. Use de-natured alcohol instead. Clear packaging tape is also great for cleaning pads. The tape will remove ink and debris without removing the silicone oils.

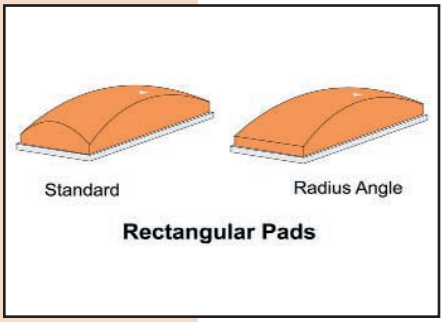

Figure 4

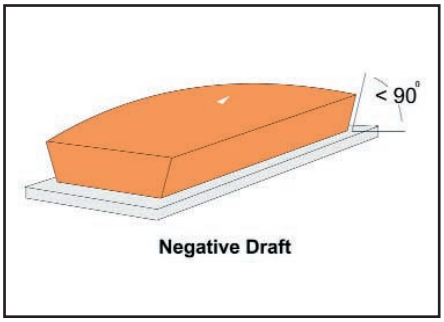

Figure 5

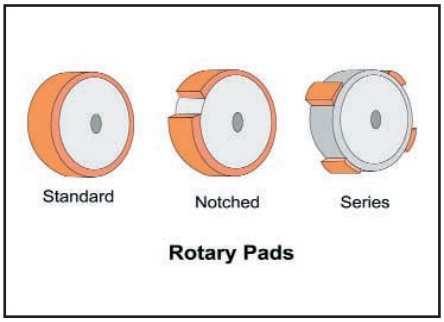

Figure 6

There are numerous "standard" textures used in the injection molding industry. Some automotive and electronics companies have proprietary textures. In an effort to find a correlation between texture size and depth and printability I contacted Mold-Tech, an internationally recognized leader in mold texturing, and obtained a visual texture standards book containing 68 molded plaques made of black ABS material. Using a steel cliché with an etch depth of .001", a hard conical pad, and a two component ink recommended for ABS, I single and double printed each plaque with a moderate cycle time (5.5 second single, 11.0 second double print). I found that the depth of the texture didn't matter as much as the size and frequency (or number) of peaks and depressions within a given surface area. Textures with a depth of up to .0055" were easily printable, provided that they featured large enough "pores." on cellular phones, where an inconsistent ink film thickness of the smallest degree becomes noticeable. Others feel that a fine texture on the surface of the pad helps keep the pad from sliding when printing slippery substrates.

Pad Swell

Exposure to most conventional solvent-based inks will cause the image area on the surface of the pad to swell a few thousandths within the first 100 impressions or so. This swelling can be beneficial since it allows the pad to pick up more ink from the etched area of the cliché. In order to capitalize on the benefits of pad swelling, many technicians will print a piece of scrap or paper until their pad swells prior to printing their first production part.

Pad Life

Pad life is a common concern. The life of any given pad depends on its initial

New Pads

New pads usually have silicone oil on the surface. The amount of oil will depend on the pad's durometer. This excess silicone oil can inhibit the pad's ability to pick up the image from the cliché, and may result in uneven image transfer. To remove this excess oil from the surface of the pad wipe it with a clean rag, dampened with a relatively fast solvent such as acetone. This should only be done with new pads.

Pad Oil

Some manufacturers sell silicone oil for rejuvenating old, dried out pads, and for protecting pads that are stored for long periods between uses. This oil can be kneaded into the surface of pads once they have lost their transfer properties, or on a regularly scheduled basis as maintenance. Pad oil is marginally effective once a pad has been dried or worn out, and then only for a limited period of time. □