Technical Information

Graphic Arts Film Materials

Linotype-Hell

The quality of the film produced by any laser output device owes a lot to the ability of the film material to record the exposure by the laser. Film quality has far-reaching affects on calibration, halftone dot quality, and edge sharpness. Understanding the difference between the three basic types of graphic arts films will help you in evaluating film produced by a scanner or imagesetter.

Lith, rapid access, & hybrid

Lith film is the oldest of the three film types, and its origin is tied up with the lithographic printing process. In the first part of this century, before commercial lithographic printing really got off the ground, film materials were continuous tone. And yet lithography as a printing process can't print continuous tone, it can only simulate it with halftone dots of various sizes. Lithographic printing requires a high contrast photographic material that produces solid black areas, clear areas, and very little in between. The resulting films developed for use in lithographic printing came to be called lith films. 'Lith' isn't really short for anything. (To call these films lithography or lithographic films misses the point.) The primary characteristic of lith film is its high contrast.

Another characteristic of lith film is that it is able to achieve a very high maximum density (dmax). To achieve this high dmax, however, requires a heavily monitored development process. Despite this, lith film is still in use today, particularly in locations that do a lot of process camera work or use older contact screen scanners.

At imagesetter and electronic dot generating scanner sites, **rapid access** films are most commonly used. These films provide good quality and a development process that is simpler and faster than lith (hence the term 'rapid access'), but they don't provide contrast as high as lith films.

Hybrid films were invented to take advantage of some of the characteristics of lith films, while retaining the convenience of rapid access films. Hybrid films perform better at higher dmax than rapid access films, but they do so at a cost. Their processor chemicals are more expensive and run at a higher pH[1]. The development time is also somewhat slower. Hybrid films may not be processed in rapid access processor chemicals. However, many rapid access films will run in hybrid processor chemicals. Kodak Ultratec** film and DuPont Quanta-One** are examples of hybrid film.

[1]High pH is necessary for hybrids because greater developer activity can be achieved in alkaline solutions. Greater developer activity allows a film to produce a higher dmax. (Note: 7.0 is a neutral pH. As alkalinity increases, so does the pH value.)

New technology developments

Recent advances in rapid access technology may narrow the gap between rapid access and hybrid films. Improved rapid access developers may allow rapid access films to perform more like hybrid films. In addition, Kodak has introduced a high contrast rapid access film that achieves high dmax and yet may be developed in conventional rapid access chemicals. This technique, called integrated booster technology, includes all of the ingredients necessary for the hybrid process in the film material instead of in the developer.[2]

[2]Higher activity materials in the film eliminate the need for high pH as a means of delivering high

Linearity

The term 'linearity' may sometimes be used to describe the way in which halftone dots percentages are translated to film. If the requested values match the measured values exactly, then the film is said to be linear. Variations from the linear may be corrected with a linearization or calibration program. No film is truly linear, but improvements in films and developers may bring them closer to that ideal.

Contrast

What is it that we mean by high contrast? Contrast describes the range of tones in an original or reproduction from the highlights to the shadows. Low contrast means that there is very little difference from one tone to the next. High contrast means that there is a large difference. An extreme example of high contrast is a two tone posterized image (see Figure 1). A high contrast film is needed to reproduce halftone dots, which are, of course, the printer's way of simulating different levels of gray with printed black halftone dots of various sizes.

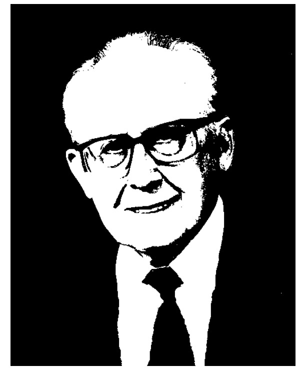

Figure 1 - High contrast image of Dr. -Ing. Rudolf Hell, founder of Hell GmbH.

Exposing film

How much exposure to light does it take to make the film start to turn black? Most high contrast, negative-working films function something like this:

- Film that receives little or no exposure stays clear after processing.
- As the amount of exposure increases, it becomes more and more likely that the film will start to turn black.
- The more exposure, the blacker it gets, up to a point.
- At some high level of exposure the film can't turn any blacker, and so even as exposure continues to increase, the dmax doesn't. However, even though the dmax may not get any blacker, the image area may grow larger around the edges. This also causes open areas to fill in.

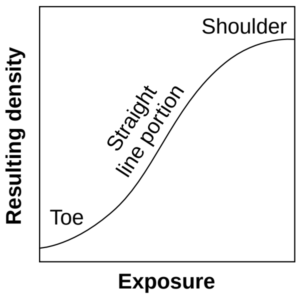

Figure 2 - Generic characteristic curve showing toe, straight line portion, and shoulder.

If you make a graph of exposure versus density (see Figure 2), the resulting curve looks like an S. This kind of diagram is often called a characteristic curve, because it defines the characteristics of a piece of film (processed under consistent conditions). The central portion of the S curve is called the straight line portion. The lower portion of the S curve is referred to as the toe, while the higher end is referred to as the shoulder.

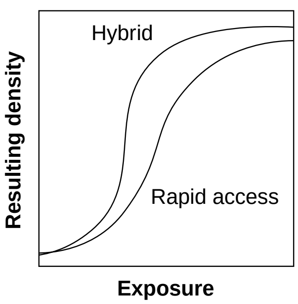

Figure 3 - Generic rapid access film versus a generic hybrid film.

The mathematically defined slope of the straight line portion of the curve, often referred to as gamma, tells us something about the contrast of the film. Films with high contrast will have a steep central portion. While rapid access and hybrid films are both high contrast, hybrid films have a steeper straight line portion. This means that hybrid films have a higher contrast than rapid access films. (See Figure 3.)

One way to compare films is to run a series of exposure tests.[3] An example of such a test is shown in Figure 4. The characteristic curve in Figure 4 is slightly different than what you might see in textbooks because we use the laser intensity setting of the imagesetter (also known as the density setting) to represent exposure on the X axis.

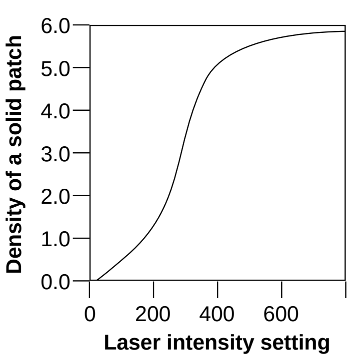

Figure 4 - Example of a characteristic curve of a rapid access film as output on a Linotronic 330.

[3]Imagesetter users can easily run a density versus exposure test using the Set Density tool in the Linotype-Hell Utility. The curve shown here is from a Linotronic* 330 imagesetter at 2540 dpi using rapid access film. Results will vary depending on shop conditions such as developer temperature and processor speed. Output scanner users can run a similar experiment by doing a light value test.

Proper film exposure is a tradeoff between dmax, edge quality and halftone dot quality. At high dmax, edge quality may suffer, particularly for small type and fine linework. When edge quality is best, measured halftone dot percentages may not match the requested values. When measured halftone dot percentages match the requested values, the dmax may be too low to burn a printing plate. In essence, the key is to find the proper exposure point on the characteristic curve, keeping in mind your shop's quality requirements.

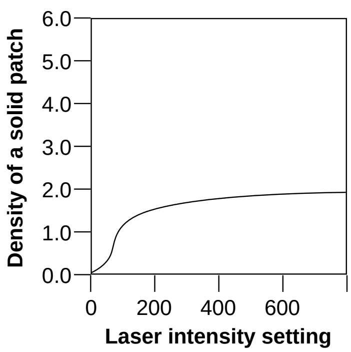

Figure 5 - Characteristic curve of a rapid access paper as output on a Linotronic 330. Note the low dmax.

With rapid access films, it is usually best to expose your film somewhere along the straight line portion of the curve. Variations in the exposure will result in only slight variations in the dmax. In addition, if you were to expose the film on the flat part of the shoulder of the curve, you might have some amount of filling-in on the negative, and also, halftone dot percentages are likely to be significantly off target. (Of course, this can be adjusted through calibration, but it is best not to have to correct for large shifts in dot percent.)

The situation is slightly different for rapid access imagesetter paper. If you expose on the straight line portion, your dmax may not be high enough (see Figure 5). If you overexpose (by moving too high up on the shoulder of the curve), you will start to see the enlargement of serifs and halftone dots in a positive, and the filling in of these areas on a negative. It is therefore important to be sure that you are not overexposing. (The Linotype-Hell technical information piece entitled Calibrating on Imagesetter Paper covers this subject in greater detail.)

With an extremely high contrast film, like the one recently introduced by Kodak, the slope of the linear portion of the S curve is so steep that small changes in exposure or processing could cause large changes in density. For this type of film it is best to expose on the shoulder of the curve. (See Figure 6.) As with paper, when exposing on the shoulder, care must be taken to avoid overexposure.

The importance of dmax

The contrast, or gamma, of a film is an important factor, but the dmax that is achievable on film is also important. Often, high dmax is preferred, but why is this the case? It is because films with low dmax may allow light to pass through in unintended areas and undermine the platemaking process. This may occur in solid black areas, or in the transition areas between solid and clear.

dmax value	Light transmitted
0.0	100.0%
1.0	10.0%
2.0	1.0%
3.0	.1%
4.0	.01%
5.0	.001%

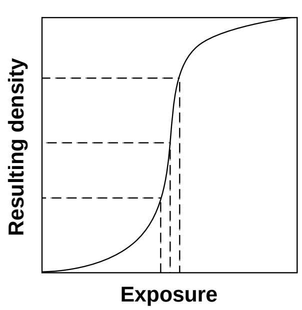

Figure 6 - Slight changes in exposure on a very high contrast film may cause large changes in dmax.

How low does dmax have to be for a significant amount of light to pass through it? The density of a piece of film is a measure of how much light will pass through, or reflect off of it. The number values attached to dmax are actually logarithmic conversions of light transmission or reflectance. For example, a piece of film with a density of 0 allows all of the light to pass through it. A piece of film with a density of 1 allows 10 percent of the light to pass through it, and so on. (See chart to right.) Minimum density ( ) on film is usually between .04 and .08.[4] Dmax on photographic paper is rarely above 2.0. Dmax on photographic film can go above 5.0. As dmax gets higher and higher, it also becomes harder to measure. You may have noticed that your densitometer takes longer to measure high density values, particularly those above 5.0. This is because so little light is making it through the film that it is difficult for the densitometer to make a measurement. Above 3.0, very little light makes it through the film. In terms of exposing a plate, most sites request dmax values around 3.5 or above for film. For paper, a dmax between 1.6 and 2.0 is sufficient for further pre-press operations.

[4]Dmin much higher than this indicates fogging of the film which may be a result of overactive development.

Fringe & edge sharpness

In any film there will be some amount of transition area, or fringe, between image and non-image areas. The extent of this fringe varies depending on a number of factors including, film type and chemistry in use, developer temperature and time, and the optical system of the exposure device. If there is a lot of fringe present, halftone dot sizes may not be accurately translated to the printing plate. It is not easy to view fringe on a conventional light table. To see it well you need to view the films under special lighting conditions using a high-powered magnifier.

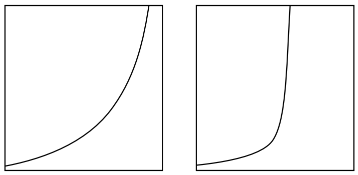

Figure 7 - A broad curving toe (left) indicates a film with less edge sharpness than one with a rapidly curving toe (right).

The characteristic curve can be used as an indication of edge sharpness. If you look at the toe of the characteristic curve you can graphically see the change from no image to image taking place. The more rapidly this curve turns, the sharper the resulting edge will be. (See Figure 7.)

There are two possible sources for soft edges: film type and method of exposure. The toe of the characteristic curve will tell you about the edge sharpness of the film type. The method of exposure can be subdivided into process camera halftones and laser halftones. A process camera halftone is by nature significantly softer than a laser halftone. Within laser output devices, the nature of the optical system will have some effect on the edge sharpness of halftone dots. (See the Linotype-Hell technical information piece entitled Hard Dot, Soft Dot for more information.) If you compare the same film, processed in the same way, but exposed on two different output devices, then you will have a fair comparison of the optical system of a given device. If you vary more than one factor, you are no longer comparing just the optical system of the output device.

Contacting

Photographic halftones are commonly contacted to remove halftone dot fringe. Contacting and duping[5] create a second generation film which, among other things, removes halftone dot fringe and assures greater consistency on press. Some people even contact rapid access films off of laser output devices, but the decision to do this depends on production requirements. The fringe on laser halftone dots is much less significant than the fringe on photographic halftone dots. Hybrid films, because of their innate edge sharpness rarely, if ever, need contacting to reduce halftone dot fringe.

[5] Duping, or duplicating, a film makes an exact duplicate, i.e., a negative stays negative. Contacting creates a reverse, i.e., a negative becomes positive. Sometimes the term contacting is used generically to describe both of these processes.

The best way to determine if contacting is necessary is to make a contact. If the dot percent values on the contact vary by more than a percent or two from the original, chances are some fringe was burned off during contacting. Films may also need to be contacted simply to provide additional copies or to create single piece films from stripped up flats.

Spectral sensitivity

Another factor in film quality is spectral sensitivity. For the film to perform optimally it must be well-suited to the light source of the laser in the output device. There are a wide range of rapid access and hybrid films for different types of lasers including: helium neon, argon ion, red-sensitive laser diode, and infrared laser diode. (For more information, see the Linotype-Hell technical information piece entitled Lasers and Films.)

Conclusion

This article has covered a wide range of variables involved in film quality. For some specific information on film defects, please refer to the Linotype-Hell technical information piece entitled Maintaining a Film Processor.

Comments

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