Hot Stamping and Pad Transfer Printing Technology

Reprinted by
AFM Engineering, Inc.
1313 E. Borchard Ave.
Santa Ana, CA 92705

Phone: 714.547.0194
Fax: 714.542.2728
Email info@afmeng.com
Web Site afmeng.com

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PROFILE OF

PROFILE OF UNITED SILICONE

United Silicone was incorporated January 2, 1976. Almost immediately it captured a place in the plastics decorating industry providing unique products and services to such growing markets as the television manufacturing industry. USI supplied silicone rubber products and meanwhile pursued expansion into the area of tooling for hot stamp systems during the late 1970's.

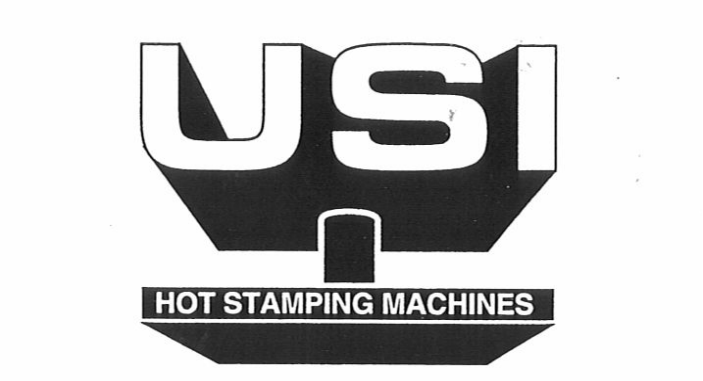
In 1977 a new manufacturing facility was constructed at USI's location in Lancaster, New York where United Silicone now employs over one hundred people. United Silicone also maintains an external network of independent representative sales organizations covering the entire United States. Since 1977 the building has undergone several expansions and numerous changes — and so have the products. The increasing complexity and sophistication of the products and services has not ceased since the early 1980's.

USI entered the pad printing industry in 1982, acting as a distributor for a line of machines manufactured in Belgium. A year later, USI introduced its own line of pad printing machines completely designed and manufactured at our facilities in Lancaster, New York. A line of custom hot stamp machines was introduced at the National Plastics Exposition in 1988, and the product line now includes a wide range of Vertical, Roll-on, and Peripheral decorating equipment.

In 1986 USI acquired Gladen Corporation, a large domestic supplier of silicone rubber products for the Hot Stamping industry. Today, United Silicone Inc. is the largest manufacturer of Hot Stamping and Pad Printing Machines, Systems, Tooling and Supplies in the United States. Our full line includes:

Hot Stamping Equipment and Supplies
Standard machines
Custom machines
Silicone rubber sheets, dies and rollers
Metal dies
Hot Stamp Foil
Part holding fixtures
Machine accessories
Pad Transfer Printing Equipment and Supplies
Standard machines
Custom machines
Silicone transfer pads
Engraved steel and nylon plates
Ink systems
Part holding fixtures
Machine accessories

Introduction



INTRODUCTION

United Silicone is the world's leader in the design and manufacture of high quality systems and tooling for the decoration of plastics. In our second decade, our broad product line includes both hot stamping and pad transfer printing systems.

With headquarters in Lancaster, New York, United Silicone is the single source for every plastics decorating need. Companies around the globe count on U.S. for our total capabilities in design and manufacturing.

Since the early 1950's the rapid development of the plastics industry has brought about a high level of part performance, allowing plastics to make inroads in areas not thought possible a short time ago. The advances made in decorative methods have been just as dramatic and hot stamping has remained the most widely utilized process. The range of applications include single or multicolored graphics, flat or contoured shapes, and small details or full coverage of large areas.

The three main methods of hot stamping are:

1. Roll-on Decorating
2. Peripheral Marking
3. Vertical Stamping

The first two methods are described in this manual, however, the majority of the details presented will cover vertical stamping. Information is provided on supplies and tooling including hot stamping foil, silicone dies, metal dies, and part holding fixtures.

NOTE: More detailed information on Roll-on Decorating and/or Peripheral Marking is available.

Advantages of Hot Stamping

ADVANTAGES OF HOT STAMPING

The most important advantages of Hot Stamping are:

A. Dry Decorating Method- No ink mixing or clean-up is required and a hot stamped part is immediately ready for handling and packaging.

B. Variety of Materials- Besides plastic materials, where emphasis is on thermoplastics, thermosets can also be hot stamped; in addition wood, book cloth, leather, textiles, paper, cardboard and pre-painted metals are stamped with success.

C. Variety of Decorating Finishes- Hot Stamping is the only decorative method where permanent gold and silver metallic graphics can be produced. Foils are also manufactured in gloss or matt pigment colors, woodgrain designs, brushed effects, and chromium for exterior use. Multicolored graphics can be accomplished with preprinted heat transfers and continuous patterned foils.

D. Variety of Surface Geometries- In addition to standard part configurations, hot stamping foils can be applied to raised beads and graphics.

E. Minimum Set-Up Time- Installation of a new color or design merely involves changing a dry roll of printed material.

F. Permanent Decoration- Hot Stamping Foil has excellent adhesion to plastic surfaces, and abrasion resistance, due to thermal bonding.

Three Main Methods for Hot Stamping

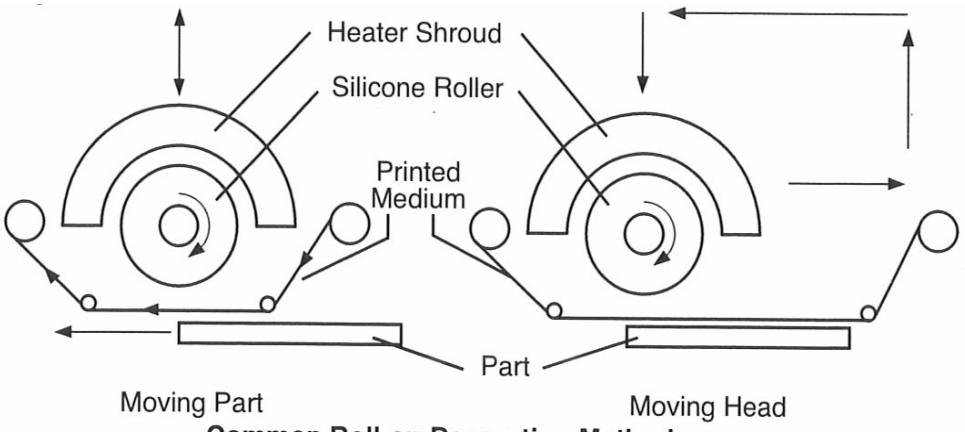
Hot Stamping & Pad Printing Technology

THREE MAIN METHODS FOR HOT STAMPING

The three main methods of hot stamping are:
-Roll-on Decorating
-Peripheral Marking
-Vertical Stamping

Roll-On Decorating

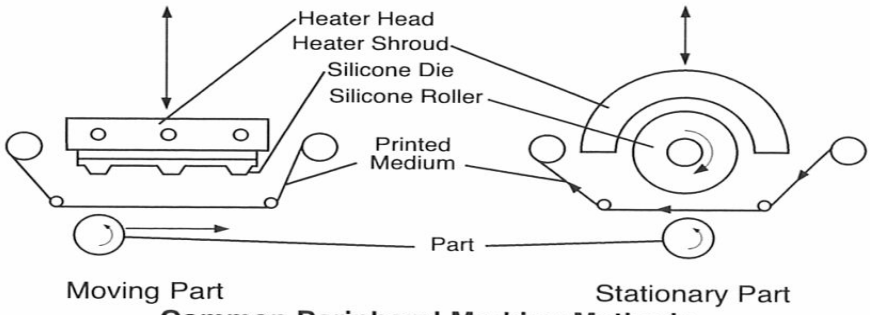
Roll-on decorating is ideal for applying foils or preprinted heat transfers to part surfaces with large areas. With this method, a silicone rubber roller applies heat and pressure to release the print medium onto the substrate. The advantage of this process is that the rubber roller material maintains line contact and pushes out trapped air between the printed medium and decorating surface so that air bubbles are eliminated.



Common Roll-on Decorating Methods

Peripheral Marking

Peripheral marking is mainly used for applying foils or preprinted heat transfers to the periphery of cylindrical as well as slightly conical parts. With this method, the piece is rolled under a flat stamping die, or roller, that applies heat and pressure to release the print medium onto the substrate. The advantage of this process is that up to 360 degrees of the part circumference can be decorated in one machine cycle.



Common Peripheral Marking Methods

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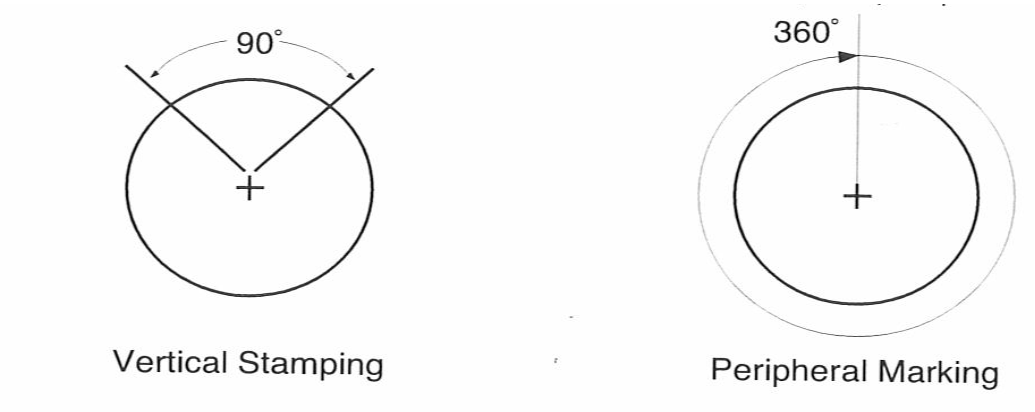
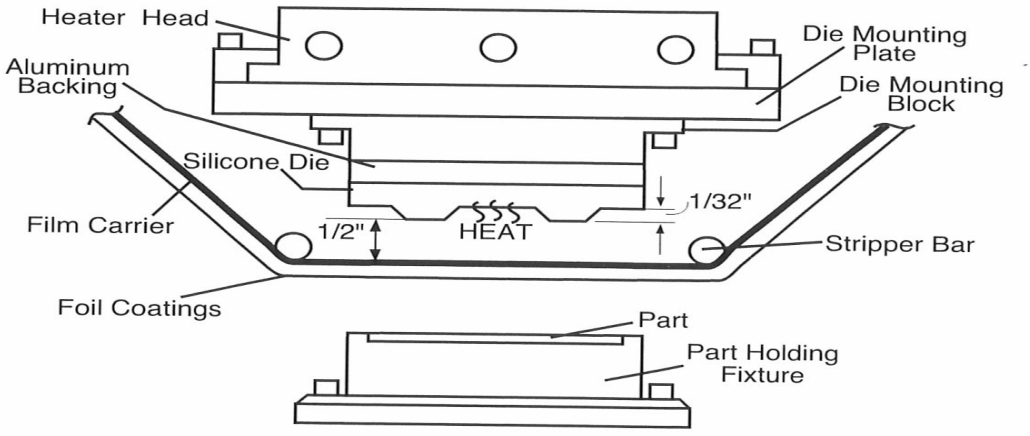
Vertical Stamping

Vertical Stamping, the most common hot stamping method, is ideal for applying foils or preprinted heat transfers to smaller areas of flat or slightly crowned parts, and to a maximum of 90 degrees on the circumference of cylindrical or spherically shaped parts.



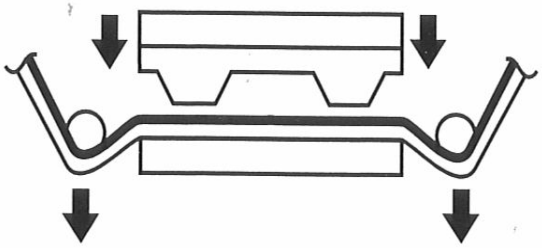
In a typical thermoplastic foil vertical stamping application, a silicone rubber die is mounted to the heater head of the vertical acting machine and positioned directly over the part decorating area. Die construction consists of heat stable silicone rubber, available in a wide range of hardness (Durometers), bonded to aluminum. The graphics to be stamped are raised on the die surface a minimum of 1/32” and are heated to a temperature near the melting point of the plastic substrate, usually in excess of 300 degrees Fahrenheit.

Suspended directly below the die, in a path defined by two stripper bars, is the hot stamp foil which consists of various thin coatings deposited on a film carrier. Typically there is approxi¬mately a 1/2” space between the foil and the hot die face so that the release characteristics of the foil are affected as little as possible by heat convection.

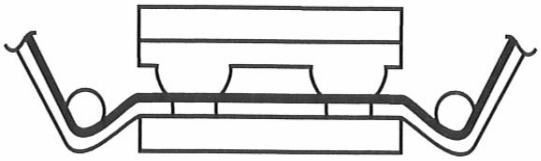


Typical Vertical Stamping Set-up

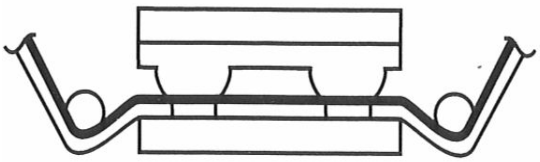
Step 1: Head Descension
When the machine sequence has been initiated, the head will descend toward the decorating surface. The foil, which travels with the head and at the same time maintains its distance from the die face, contacts the part first and the stripper bars act to push the foil tightly over the surface to remove any wrinkles.



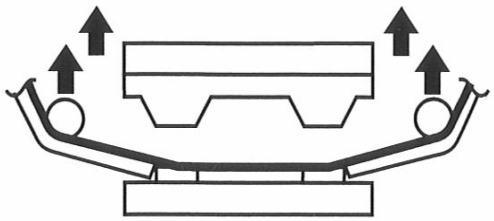
Step 2: Die - to - Part Contact
A fraction of a second after the foil is pushed over the part, the hot stamp die surface makes contact simultaneously with the foil and the rigidly supported plastic piece. The pressure that is exerted accomplishes two things. First, the silicone rubber will compress and conform to any small surface variations in the part decorating area so that even contact is achieved. Second, the foil resins in the graphic area will break cleanly creating a parting line.



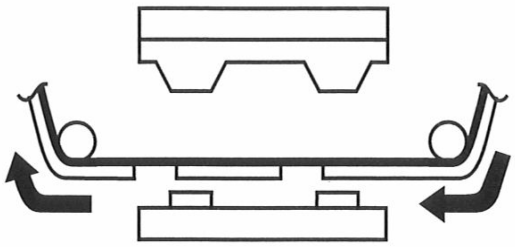
Step 3: Dwell Time
During the dwell time, the period that the hot die is in contact with the foil and part, heat conduction will cause the release agents and resins of the foil coating to soften. At the same time the substrate surface will begin to soften and the pressure exerted by the machine will help the resins penetrate the molten plastic to promote thermal bonding.



Step 4: Head Retraction
At the end of the dwell time the head of the machine will retract and begin its ascent to the start position. First, the hot stamping die lifts away from the substrate while the foil remains on the surface for a split-second allowing the foil and part resins to begin to cool and harden. Then as the die continues to rise, the foil will be peeled away, starting from the edges and working to the middle, At this point, the adhesion between the substrate and the foil coatings is greater than the bond between the release agents in the coatings and the film carrier, resulting in a virtual complete deposition of the foil coatings.



Step 5: Foil Advance
As soon as the head of the machine returns to its original position the foil will advance and an unused section will be positioned under the die. Finally, the hot stamped part can be removed from the fixture and handled or packaged as necessary without any danger of rubbing the graphics off of the substrate.



Hot Stamping Foil

HOT STAMPING FOIL

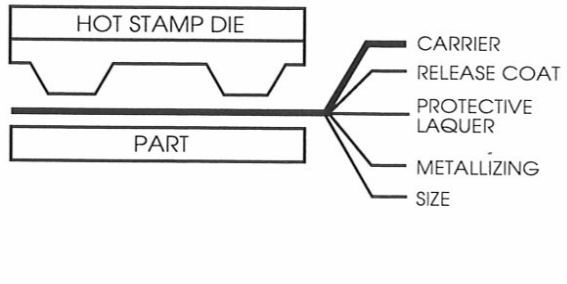
Hot stamping foil is available in an infinite variety of colors and designs. The most common foils are metallics and pigments but woodgrain designs, brushed effects, continuous patterns, and chromium for exterior use are also used extensively.

Regardless of the type of finish, all foils consist of various thin layers deposited on a film carrier. The main function of the carrier is to deliver the print medium to the hot stamping area and it should be able to withstand the heat of the operation without breaking or distorting. The material, typically polyester in 1/2, 3/4 or 1 mil thickness, also acts as a barrier from the heated die to protect the release characteristics of the foil.

Carrier thickness selection is based on the hot stamp application and/or foil coating configuration. For example, because all plastic films react to heat by wrinkling, a thicker carrier would be used for an application that requires a lengthy dwell time and/or an excessive die surface temperature. Furthermore, certain foils with many layers of thick coatings - like a woodgrain design - require a thicker carrier to support the extra weight.

Metallic Foil Construction

Release Coat-This is usually a wax coat which melts at a specific temperature to release the decorative coatings from the carrier.



Protective Lacquer- Once the print medium is released from the carrier, this layer is the top coating on the decorated substrate and it provides abrasion and chemical resistance. The lacquer also defines color. For example, a transparent amber tinted lacquer is used for gold foil.

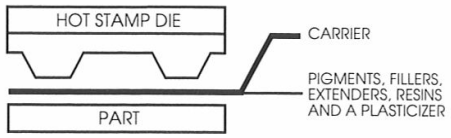
Metallizing- The vacuum metallizing process is used to provide the mirrored finish of a metallic foil.

Size-The purpose of this coating is to bond the stamping foil layers to the part. It consists of resins which match those in the sub-strate to be decorated. For example, to stamp polypropylene an adhesive is used which fuses to polypropylene. Furthermore, in high specification work, additional size coats may be required to strengthen the bond with the metallized layer.

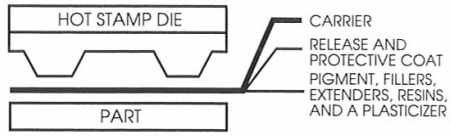
Pigment Foil Construction

The most common pigment foils are made in matt, gloss, or day-glo finishes.

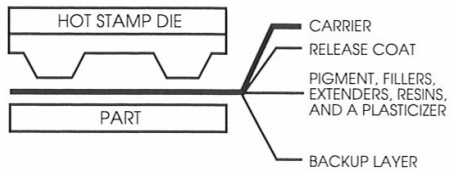
Matt Pigment Finish-The composition of this foil includes colored pigment particles, fillers, extenders, resins and a plasticizer to bind the materials to the film carrier. Unlike metallic foils, which have four distinct coatings, matt foils have all of the materials mixed in a single coating. With this configuration the particles “split” from each other as the foil strips from the plastic part leaving some residue on the carrier. Matt foils have a disadvantage to the user-they are scratched easily and they can smear.



Gloss Finish-The composition of this foil includes two layers. The first is very similar to that of the matt finish except that more resins are added which make the finish glossy and tighten the release. The additional layer is used to help release the particles from the film carrier onto the part and at the same time protect the stamp from marring and smearing.



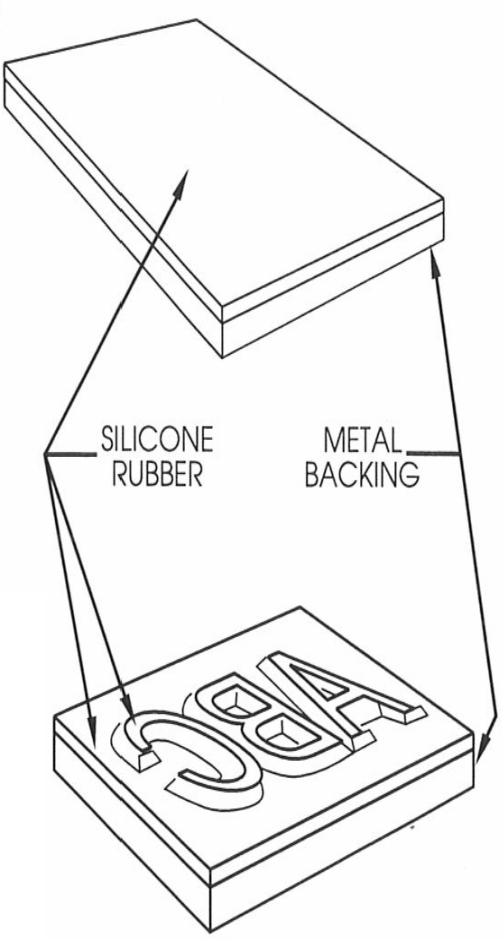
Day-Glo Finish-These bright colored foils are composed of three layers. The first is very similar to that of the matt finish except that more pigment particles are added to improve opacity. The back-up layer comes next and it is like the first but the color is white to provide additional opacity so dark part colors won’t show through. The final layer is used to help release all the particles from the film carrier onto the part.



Silicone Rubber Sheets and Dies

SILICONE RUBBER SHEETS AND DIES

Silicone rubber tools conform to the surface variations inherent in plastic molded parts, and have earned the position as the material of choice in decorating applications. United Silicone offers custom formulations with balanced properties for superior high-heat performance. Our proprietary rubber-to-metal bonding systems encourage long life, and rigid process controls assure consistent product quality.



Silicone Rubber Sheet Stock
This material is commonly used for tipping raised graphics and beads, or for applying multi-color heat transfers

- -Available in thousands of combinations of material, size, and thickness for virtually any application.
- -Carefully molded, cured and precision ground for quality and performance.
- -May be utilized flat or can be bent to fit workpiece contours.
- -Custom trimming and finishing services available.

Custom Molded Dies
Silicone rubber dies are popular for hot stamping graphic on flat or contoured parts.

- -Full graphic art and photographic capability assure faithful art reproduction.
- -Complete in-house mold making expertise provides rapid delivery.
- -Available in flat, multi-level, or contoured configurations for diverse applications.
- -Custom trimming and finishing services available.

Silicone Rubber Product Comparison

Silicone rubber has many properties that affect the decorating performance of sheets and dies. The material should be carefully chosen to suit the needs of the project.

The accompanying product comparison table will assist you in selecting the proper material for the decorating application. All United Silicone rubber formulations are HTV high performance materials (High Temperature Vulcanizing),compounded in state-of-the-art equipment with advanced process controls and designed with excellent heat stability and physical properties.

Formulation	Description	Application
Supersil (red color)	Excellent general-purpose material specifically formulated for fast-turnaround	Conventional vertical operations requiring moderate temperatures and cycle times - typically manually fed.
Ultrasil (red color)	Premium, high-performance material with outstanding rubber-to-metal bondability	Demanding vertical operations requiring high temperatures and/or high pressures - usually manually fed.
Thermosil (Dark brown color)	Advanced, high performance material with enhanced heat recovery properties	Semi-automatic and automatic vertical operations requiring very stable high-temperatures and very rapid recovery.

SILICONE RUBBER PRODUCT SPECIFICATIONS

Specification	Sheets	Molded Dies
Rubber Formulation	See Product Comparison on previous page	
*Rubber Durometer (Hardness)	40-90 (80 Durometer is standard)	40-90 (80 Durometer is standard)
*Dual Durometer	Available	Available
*Texture	Available	Available
Size	12” x12” to 36” x 48” (12” x 12” most common)	Up to 22” x 25”
Raised Graphics	Not Available	1/32” to 1/16” (standard)
*Silicone Thickness	1/32” to 1/2” (1/8” most common)	1/32” to 3/16” (1/8” most common)
*Metal Backing	Half-hard Aluminum (standard), 1/64” to 1/2” Dead-soft Aluminum (bendable), 1/64” to 1*/2” Steel, 1/64” to 1” Brass, 1/32” to 1”	Half-hard Aluminum (standard), 1/64” to 1/2” Dead-soft Aluminum (bendable), 1/64” to 1*/2” Steel, 1/64” to 1” Brass, 1/32” to 1”
Contact Surface Shapes	Bi-level (Surface Ground)	Bi-level, *crown, on contour

* For more information on this item, please see the next page.

Notes on Specification

Rubber Durometer- Measure of material hardness as expressed on the Shore A Scale. Low Durometer rubber exhibits high-elongation properties and improves coverage on irregular surfaces. Rubber in higher Durometer ranges is more tear resistant and will withstand pressure with minimum distortion.

Dual Durometer- Two different rubber Durometers are molded together in levels. Usually a harder material is used in the face and a softer one in the background. This provides a soft pliable belly beneath the printing surface to help absorb variations in part wall thickness etc.

Texture in Contact Surface- For vertical applications with large surface areas, a texture in the rubber face will help redistribute trapped air.

Silicone Thickness- The thicker the material the better the die life. However, the heat transfer is reduced. (See page 23 for more information)

Crown in Contact Surface- For vertical applications with large surface areas, a convex crown (as little as .010') in the rubber face will help eliminate air entrapment.

Metal Backing- Silicone rubber bonds much better to aluminum than steel or brass. The aluminum is more porous than the other materials and effectively provides a larger bonding area.

COMMON CAUSES FOR SILICONE DIE FAILURE	
Cause	Symptom
Over Compression	
Over compression of the die causes lateral forces at the bond which leads to delamination. Always be sure the set up is as parallel as possible and use minimum stamping forces.	Delamination, with black or grey powder residue at the bond line.
Excessive Heat	
United Silicone rubber materials withstand service temperatures over 600 degrees F - the highest in the industry. However, die life will be shortened dramatically when exceeding practical limits. Oftentimes using thinner rubber will allow you to lower your platen temperature as much as 100 degrees F and still achieve the same die face temperature. Thinner rubber also allows faster heat recovery times between cycles.	Rubber is brittle or appears driedout. When the temperature over 600 degrees F are used, delamination may occur.
Compression Set	
Stamping on narrow raised areas such as beads and lettering will ultimately cause the rubber die or pad to take a permanent set. When this condition becomes extreme, stamping quality will decline.	Depressions in the rubber contact surface.
Cutting and Tearing	
E xcessive pressure, sharp part edges and/or misloaded parts are the most common causes of cutting and tearing. Obviously avoiding these conditions will improve die life.	Fractures in the rubber surface.
Thermal Shock	
Extreme and rapid temperature changes can cause thermal expansion beyond the bond capability of the material. Many users leave hot stamping machines on after-hours to avoid constant temperature changes. This also reduces start-up time at the next production period.	Rubber is brittle or appears driedout. Partial delamination may occur.

PROPERTIES OF SILICONE RUBBER FORMULATIONS

Formulation	Durometer (Shore A)	Tensile Strength (PSI)	Elongation (%)	Compression Set (%)	Heat Resistance (°F)	Specific Gravity
SUPERSIL (Red color)	90	755	140	14	500	1.77
	80	760	140	15	500	1.73
	70	730	180	12	500	1.67
	60	760	250	13	500	1.57
	50	830	440	15	500	1.45
	40	1060	585	10	500	1.26
ULTRASIL (Red color)	90	980	60	30	600	1.74
	80	1080	120	24	600	1.73
	70	1000	170	20	600	1.57
	60	1010	240	18	600	1.45
	50	910	380	17	600	1.36
	40	820	520	15	600	1.12
THERMOSIL (Brown Color)	90	780	95	30	600	2.11
	80	900	130	24	600	2.03
	70	805	220	24	600	1.84
	60	710	310	25	600	1.64

Explanation of Terms

DUROMETER - The hardness of a material as measured on on the Shore A scale. (90 Durometer = hardest)

TENSILE STRENGTH - The pulling stress just before the material breaks into two pieces. (1080 psi = strongest)

ELONGATION - The fractional increase in length of a material, stressed in tension, just before it breaks into two pieces. (580% = most elastic)

COMPRESSION SET - The measure of material resiliency after being subjected to compression and heat. (10% = most resilient)

HEAT RESISTANCE - Ability of a material to remain bonded to metal during exposure to extreme temperature. (600 degrees Fahrenheit = most resistant)

SPECIFIC GRAVITY - The density of a material divided by that of water. (2.11 = best thermal conductivity)

SILICONE RUBBER HEAT LOSS

Station Thickness (Inches)	.010	.020	.032	.062	.125	.250	.375	.500	.625	.750	.875	1.0
Temp. Reading	360	350	330	310	290	270	250	230	220	210	200	190
Temp. Difference	40	50	70	90	110	130	150	170	180	190	200	210
% Difference	10	12 1/2	17 1/2	22 1/2	27 1/2	32 1/2	37 1/2	42 1/2	45	47 1/2	50	52 1/2

NOTES: PLATEN TEMPERATURE = 400 °F. READINGS TAKEN TO NEAREST 10 °F

TEMPERATURE DIFFERENCES BETWEEN SILICONE DIE SURFACE AND PLATEN WOULD BE GREATER IF HEAT WERE BEING ABSORBED BY PARTS BEING DECORATED, AND WOULD DEPEND ON STAMPING RATES AND PART TEMPERATURE.

Metal Hot Stamping Die

METAL HOT STAMPING DIES

Silicone Rubber Hot Stamping Dies conform to the surface variations inherent in plastic molded parts, and have earned the position as the material of choice in most decorating applications. However, there are certain situations where metal dies provide certain advantages.

COMPARISON OF SILICONE RUBBER DIES TO METAL DIES

Category	Silicone Rubber Dies	Metal Dies
Materials Available	Supersil Ultrasil Thermosil	Magnesium Copper Brass Steel
Average Die Life	Contoured-X Flat-2X	Magnesium-Y Copper-4Y Brass-18Y Steel-20Y+
Compensate for Surface Variations (Sinks, etc.)	Usually	No
Compensate for Variation in Material Thickness	Usually	No
Set-up Time	Fast Process	Lengthy Process
Approx. Pressure Req.	350 lbs./In^2	2000 lbs./In^2
Approx. Thermostat Temperature Required	100 degrees Fahrenheit more than metal (approx. 350-400 degrees F)	100 degrees Fahrenheit less than rubber (approx. 250-300 degrees F)
Approximate Dwell Time Required	50% more than metal	30% less than rubber
Decorative Finish	Usually foil lays on top of plastic surface, more consistent decoration	Die imbeds foil into plastic surface, less consistent decoration
Price	-Makeready (Mold) Charge -Initial Die less expensive than metal	No Makeready -Initial Die more expensive than rubber NOTE: Magnesium $ Copper 2x$ Brass 8x$ Steel 10x$
	-Spare Die Same Cost as initial die	-Spare Die Same Cost as initial die

DIE COMPARISON (cont.)

Category	Silicone Rubber Dies	Metal Dies
Acceptable Thermoplastic Substrates (*Indicates preferred die)	ABS Acetal Acrylic Polyamid (Nylon) Polycarbonate Polyethylene Polystyrene *PVC - Plasticized PVC - Rigid *SAN UV Coating	ABS *Acetal Acrylic *Polyamid (Nylon) *Polycarbonate *Polyethylene Polystyrene PVC - Plasticized PVC - Rigid SAN *UV Coating
Acceptable Thermoset Substrates (*Indicates preferred die)	Epoxy/Epoxy Coating Polyurethane	Epoxy/Epoxy Coating Phenolic *Polyurethane

Five Phases for Tooling Set Construction

FIVE PHASES FOR TOOLING SET CONSTRUCTION

Many times, during discussions about custom tooling sets, the emphasis is placed on the part holding fixture details. However, it should be noted that a fixture comprises only half of the set. The other half of the equation, the hot stamping die, is equally important and should be correctly mated to the fixture in order to function properly. The components should be manufactured together to guarantee a good fit and to ensure that they are parallel to each other.

Our tooling expertise includes mold making to support our silicone rubber operations, pattern making, duplicating, engraving, and conventional machining. We produce part holding fixtures, die mounting blocks or foundations, and many other components in a variety of materials including aluminum, a range of rigid and resilient casting compounds, nylon, teflon, PVC, brass, and steel.

Tooling design can be deceptively simple although many parameters exist, even for relatively easy applications. No matter what kind of part is involved, the following phases are always completed when building a custom hot stamp tooling set.

PHASE I	MANUFACTURE THE PART HOLDING FIXTURE
PHASE II	PRODUCE THE MASTER MOLD
PHASE III	MACHINE THE DIE MOUNTING BLOCK OR FOUNDATION
PHASE IV	TEST THE TOOLING SET
PHASE V	PROVIDE OPTIONAL ALIGNMENT AIDS

Please see the following pages for a discussion of each of the phases listed above. A contoured silicone rubber hot stamping application is used as example but the same details would hold true for flat applications utilizing silicone rubber or metal dies.

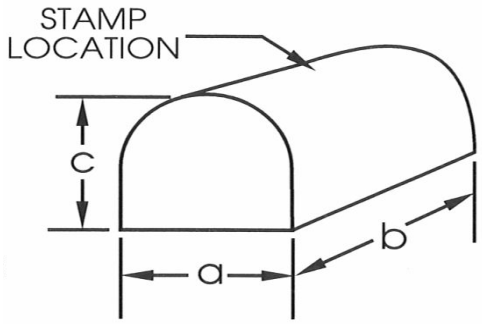
PHASE I: MANUFACTURE THE PART HOLDING FIXTURE

The first component to be manufactured is the holding fixture which locates the part and supports the decorating surface. Regardless of the application-flat or contoured-fixture construction is virtually identical. Fixturing components are produced in a variety of materials including aluminum, a range of rigid and resilient casting compounds, nylon, teflon and PVC.

The following steps are always used when building a custom part holding fixture.

A. Evaluate the part
B. Develope the fixture design
C. Manufacture the fixture

EXAMPLE



ARTWORK REFERENCE:

ABC®

Step A- Evaluate the Part

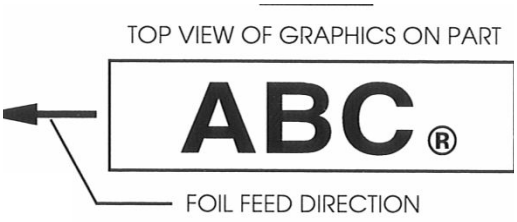
Key elements to look for:

1. Part Dimensions
2. Stamp Location, Size, and Orientation
3. 1st or 2nd Surface Application
4. Flat or Contoured Surface
5. Number of Cavities in Mold
   When multiple cavities are involved and the part consistency is poor, then a dimensional analysis is performed. A "median" part is chosen to develop the fixture.
6. Parts Decorated Warm or Cold
   If the parts are decorated directly after molding, then they will be a different size than the cold parts provided

Step B - Develop the Fixture Design

Key elements to look for:

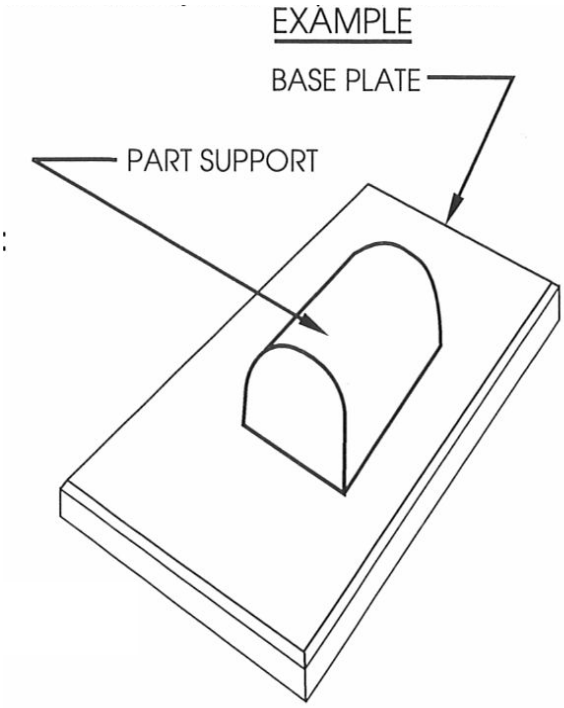
1. Part Orientation Relative to Foil Feed Direction
2. Decorating Surface Height
3. Fixture Mounting with Bolts or Toe Clamps
4. Manual or Automatic Part Loading/Discharge



Step C - Build the Part Holding Fixture

Key elements:

1. The decorating surface should be presented as parallel as the possible to the head of the machine.
2. The fixture should "hold" the part firmly in place throughout the stamping cycle, and it should be designed so that part-to-part location is consistent.
3. Support behind the decorating surface is essential regardless of how rigid the plastic part seems. Even minimal part or fixture deflection can lead to decoration quality problems.
4. The various components of the fixture are constructed directly from the parts, not from a part print.



Base Plate Materials:

For part holding fixture base plates,aluminum is used most often as opposed to steel:

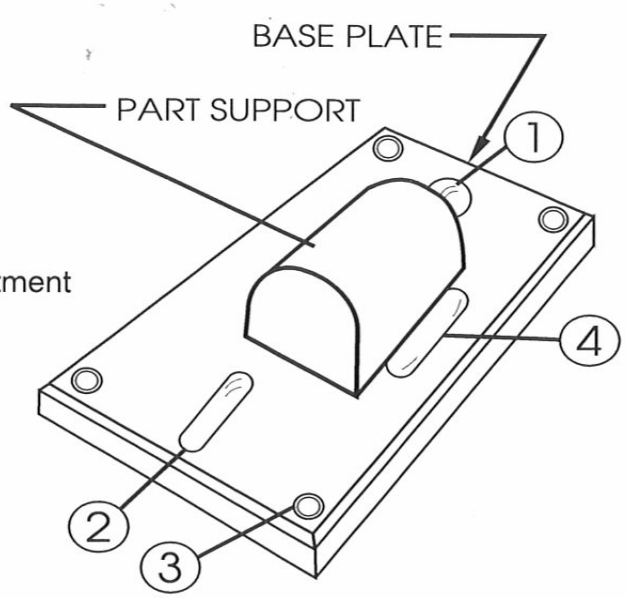
1. Lighter than steel, easier to handle
2. Easy to machine
3. Will not rust
4. Durable

Part Support Materials:

1. Aluminum - Same arguments as on Base Plate Materials.
2. PVC - Machined to the part configuration
   a. Won't scuff clear plastics or substrates with a high gloss finish
   b. Not as durable as aluminum
3. Nylon or Teflon
   a. Won't scuff plastics
   b. Ideal for automatic part discharge applications because of low friction
   c. Not as durable as aluminum
4. Cast Urethane - A coating of Urethane is bonded to a metal base, ideal for contoured applications
   a. Provides tighter fit than aluminum, PVC, nylon, or teflon since Urethane is cast directly from the part
   b. Not as durable as aluminum

Common Part Holding Fixture Options:

1. Mounting Holes
2. Mounting Slots for Positioning Adjustment
3. Jack Screws in Corners for Leveling Adjustment
4. Finger Slots for Grasping the Part



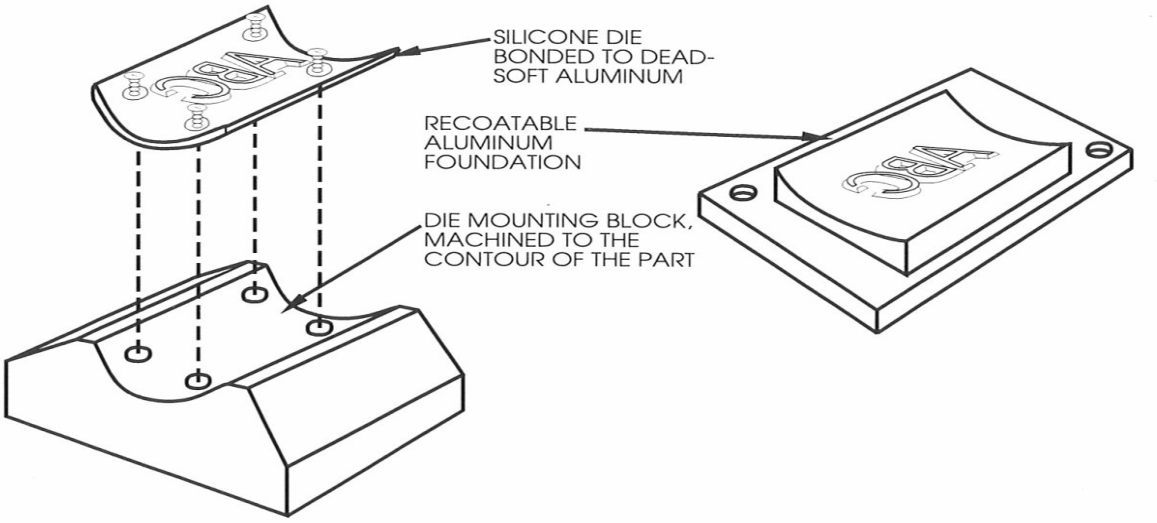
PHASE II: PRODUCE THE MOLD

Flat or contoured silicone rubber dies are made by the compression molding process. The molds are manufactured by either a photoengraving or machining process and to obtain an accurate fit, decorating surface configurations are duplicated from an actual fixtured part.

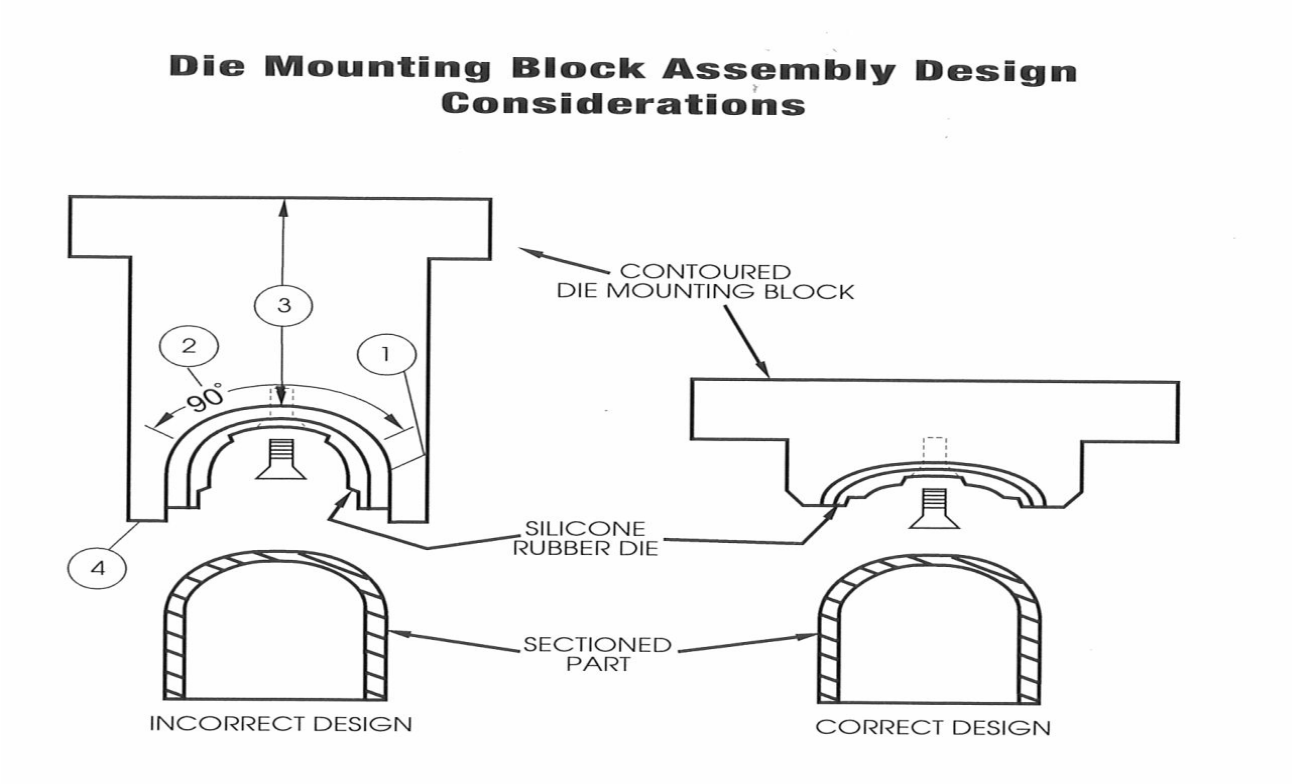
This technology is propriety but can be reviewed during a visit to United Silicone. (A non-disclosure agreement must be signed).

PHASE III: MACHINE THE DIE MOUNTING BLOCK OR FOUNDATION

Comparison of Die Mounting Blocks and Foundations



Category	Die Mounting Block	Foundation
Purpose	Provide support for the silicone rubber decorating surface and help distribute the heat evenly	
Material	Usually Aluminum	Usually Aluminum
Silicone Die Fastening	Silicone is bonded to flat dead-soft aluminum then bent to the shape and fastened with screws	Silicone is bonded directly to the foundation
Silicone Replacement	Discard worn die and replace with new one	Return foundation for new coating
Set-up	Labor intensive with many adjustments	Quick and repeatable
Contour Match	Variable	Exact
Typical Application	Short runs of many logos on the same part	Long runs of relatively few logos on the same part and/or when a graphic must be produced consistently and with extremely good detail.



Design Problems

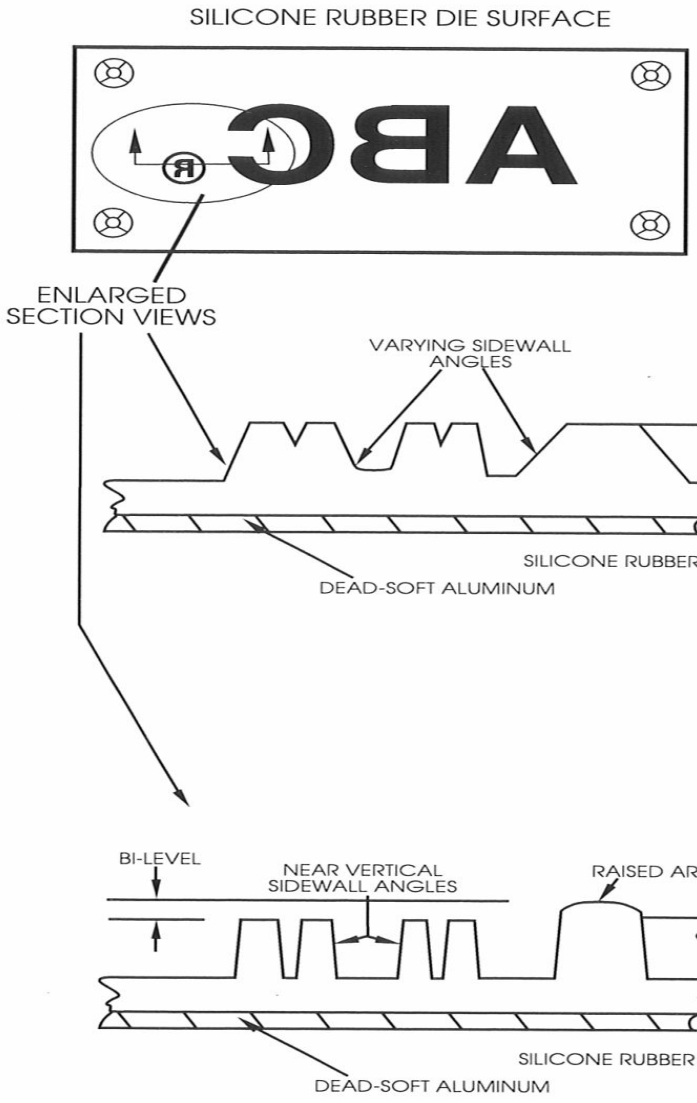
1. The die mounting surface incorrectly matches the general contour of the part and is too tight. The machined radius should be determined by considering the part contour, die thickness and heat expansion of the metal.

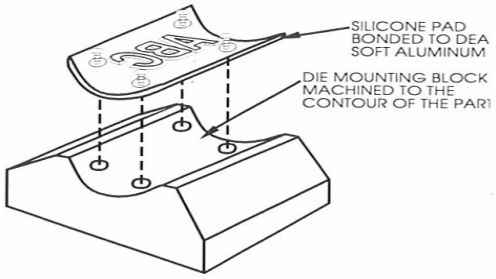
2. The width of the die contact surface is excessive. It should be sized so that a distance equivalent to 90 degrees of the part periphery is not exceeded, otherwise the die will try to "skid" at the outermost edges and a lack of stamping pressure will result.

3. The aluminum thickness should be no more than 1/2" at the narrowest point to minimize the opportunity for heat loss. Furthermore, Helicoil inserts should be pressed into the drilled mounting holes to provide long-term holding power for threaded fasteners. Since aluminum is typically used for the mounting block, a tapped hole can be easily stripped.

4. The outermost edges at the thickest points of the mounting block should be designed so that any contact with the foil is minimized. Also, sufficient aluminum mass at the edges is required to ensure proper heat transfer to the silicone rubber.

See the next page for more design considerations.





Flat Silicone Die Produced from Photo-engraved Mold

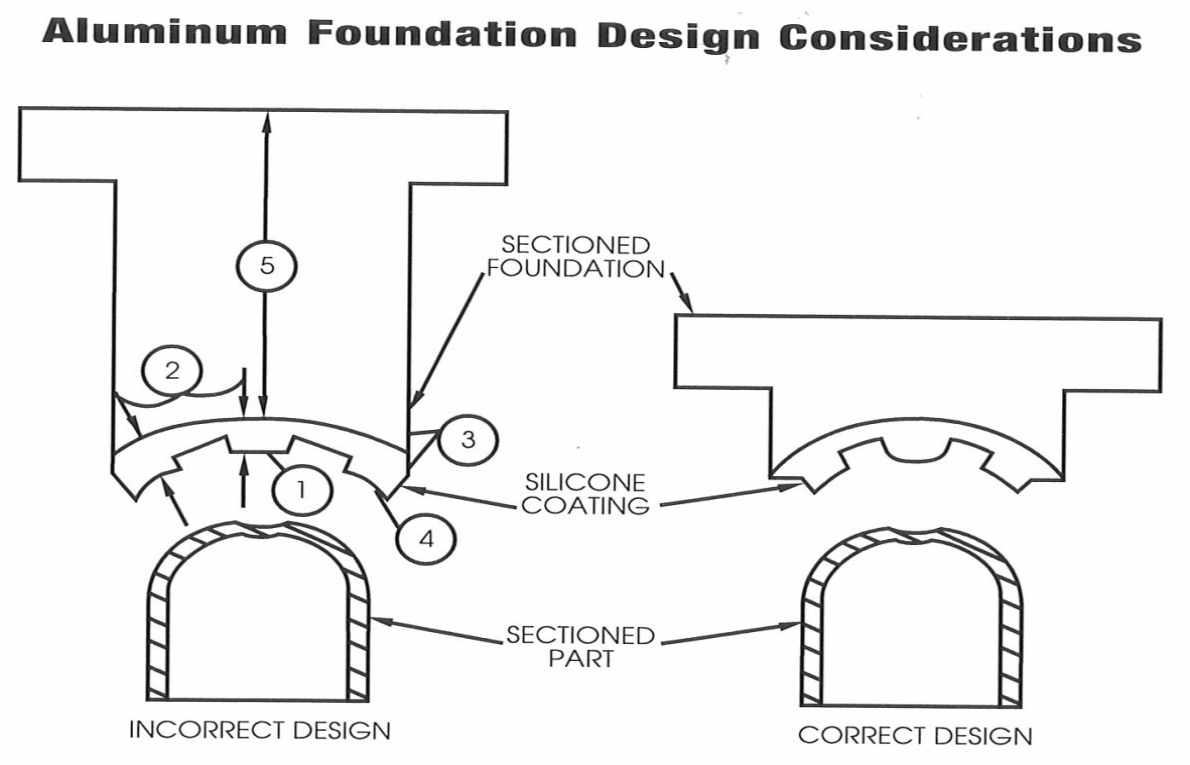
Advantages

- Initial mold charge is inexpensive which is ideal for short runs of many logos on the same part. However, the sidewall angles and character depths throughout the graphic area are inconsistent.
- Each mold can be produced within 3 working days which is ideal for the fast-turnaround that is usually required.

Flat Silicone Die Produced from Machined Mold

Advantages

- Since each character is individually engraved, the sidewall angles throughout the graphic are consistent and can be made near vertical to optimize graphic definition.
- Since each character is individually engraved, the stamping surface can be configured in a bi-level format. A small detail that is adjacent to a broad graphic can be machined .002" to .005" lower so that most of the stamping force is absorbed by the larger surface. With compression the small graphic will see minimal force and graphic definition will be optimized.
- All areas of the mold can be scraped and polished to produce a raised area in the rubber to "reach" into a sink in the part.



Design Problems

1. The surface of the die follows the general contour of the part. The mold has not been scraped and polished so that the extra rubber will be available to "reach" into the sink on the part. Without the added material air will be trapped.

2. The rubber thickness is not consistent throughout the die, thus the heat transfer will not be even.

3. There is no aluminum support behind the tips of the pad. The rubber will deflect under the force of the machine causing a lack of stamping pressure in this area. Also, there will be a heat sink at the outermost edges of the silicone since the rubber thickness is increased.

4. In vertical applications, it is not safe to decorate beyond 90 degrees of the periphery of the part. Proper pressure is not developed in this area.

5. The aluminum thickness should be no more than 1/2" at the narrowest point to minimize the opportunity for heat loss.

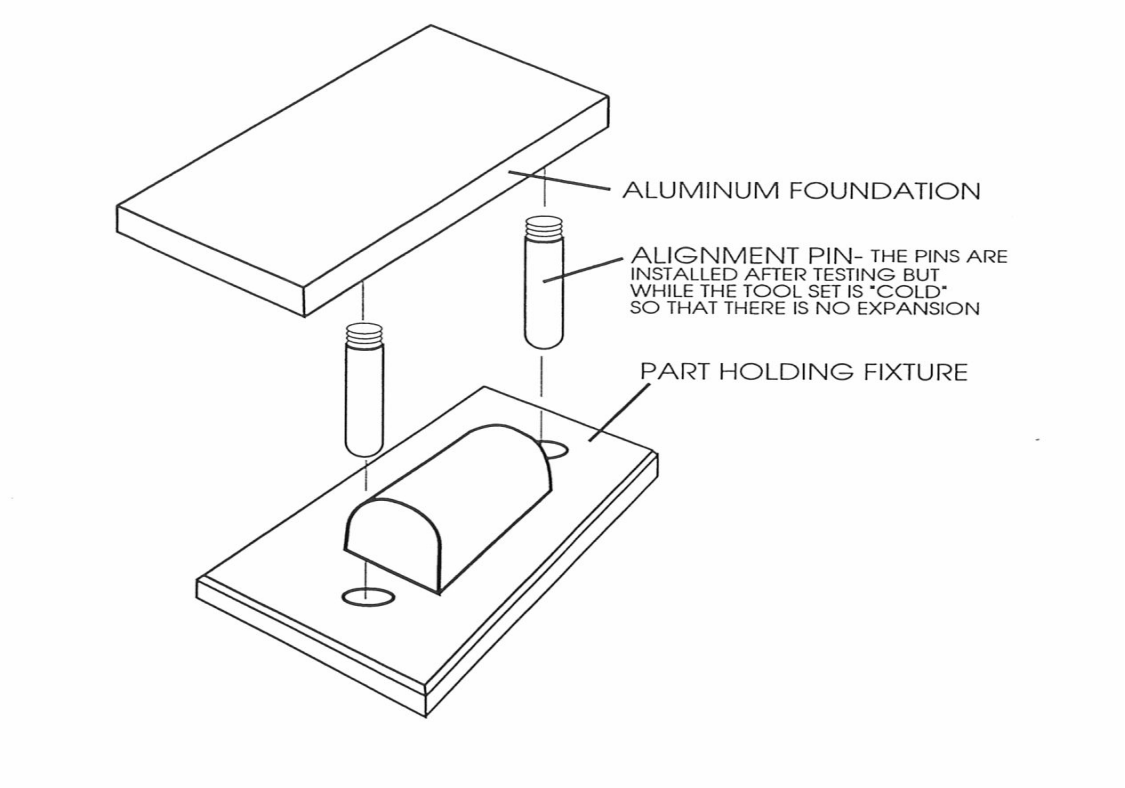
PHASE IV: TEST THE TOOLING SET

-Every tool set is tested ar the plant before shipping
-Items Required:

1. Production Parts
2. Approved Hot Stamp Foil

-Parts are shipped to the customer for approval, if requested.

PHASE V: PROVIDE OPTIONAL ALIGNMENT AIDS



Hot Stamping Troubleshooting

Hot Stamping Troubleshooting

Problem	Cause	Remedy
Incomplete hot stamped image	-Unevem die-to-part contact	-Reposition fixture so decorating surface is parallel to a flat die or conforms to a contoured die
	-Plastic part contamination	-Discontinue use of flow agents, anti-stat solutions and/or silicone based mold releases
	-Foreign particles on decorating part surface	-Clean surface with white cotton clothor glove
	-Insufficient fixture support permits the part to flex under the force exerted by the machine	-Redesign fixture to provide rigid support under decorating surface of part and/or ensure that mandrel-type designs do not deflect
	-Air entrapment between foil and part surface	- Redesign die face to include convex crown
Rollover in the hot stamping image	-Uneven die-to-part contact	-Reposition fixture so decorating surface is paralle to a flat doe or conforms to a contoured die
	-Excessive force exerted by the machine	-Decrease stroke length and/or reduce machine output
	-Die face is too hot	-Reduce thermostat setting on the machine
	-Lengthy die-to-part contact duration (dwell time)	-Reduce dwell time setting on the machine
	-Sinks in the decorating surface	-Introduce makeready beneath the part in the areas that are hitting light, then reduce forces as indicated above
	-Variations in the wall thickness from part-to-part	-Switch to a dual durometer silicone rubber die

Troubleshooting (cont.)

Problem	Cause	Remedy
Edges of hot stamped image are not “sharp”	-Insufficient force exerted by the machine -Plastic part contamination -Die face temperature is not hot enough -Short die-to-part contact duration (dwell time) -Foil stripping conditions -Foil coatings are effected by lengthy heat ewxposure prior to the cycle	-Provide adequate stroke length and/ or increase machine output -Discontinue use of flow agents and/or silicone based mold releases -Increase thermostat setting on the machine -Increase dwell time setting on the machine - Slow head retraction and/or introduce head-up delay -Use before/after foil selector to advance foil just prior ro head d escension
Poor foil-to-part adhesion	-Insufficient heat at the die face -Short die-to-part contact duration (dwell time) -Plastic part contamination -Foreign particles on decorating part surface -Foil-to-part incompatibility	-Increase thermostat setting on the machine and/or move the thermocouple closer to the die face -Increase dwell time setting on the machine -Discontinue use of flow agents, anti-stat solutions and/or silicone based mold releases -Clean surface with white cotton cloth or glove -Switch to different foil formulation

Introduction

Uni-Printer

PAD TRANSFER PRINTING SYSTEMS
by

UNITED SILICONE INC.

INTRODUCTION

United Silicone is the world's leader in the design and manufacture of high quality systems and tooling for the decoration of plastics. In our second decade, our broad product line includes both pad transfer printing and hot stamping systems.

With headquarters in Lancaster, New York, United Silicone is the single source for every plastics decorating need. Companies around the globe count on U.S. for our total capabilities in design and manufacturing.

For years, hot stamping and screen printing have dominated the decorating industry. Now, pad transfer printing is finding increasing favor for industrial and commercial applications but the process itself is somewhat befuddling. For example, a common question is, "If the ink is so attracted by the silicone pad that it leaves the recessed areas of the printing plate, why does it abandon the pad so completely upon touching the substrate?"

The information presented in this manual will answer the question above. Information is also provided on supplies and tooling for pad transfer printing including engraved plates, doctor blades, silicone transfer pads, inks, and part holding fixtures. Also, the advantages of pad transfer printing are summarized and troubleshooting recommendations are presented.

Advantages of Pad Transfer Printing

ADVANTAGES OF PAD TRANSFER PRINTING

The most important advantages of Pad Transfer Printing are:

A. Variety of Part Geometries- Due to the flexibility of the silicine transfer pad, inks can be printed on a multidue of complex contoured decorating surfaces.

B. Variety of Part Surfaces- Various degrees of textured surfaces can be printed.

C. Variety of Materials- Besides plastic materials, where the emphasis is on Thermoplastics, Thermosets can also be Pad Printed; in addition glass, metals, wood, leather and paper are decorated with success.

D. Duplcation of Fine Detail- Graphics with stroke widths as small as .033” can be accurately and consistently reproduced.

E. Wet-on-Wet Capability- Unlike screen printing, a seconf coloe can be printed over a first color immediatley.

F. 4-Color Process- The four primary colors-magenta, yellow, cyan, and black- can be printed in combination to reproduce images in all colors of the spectrum.

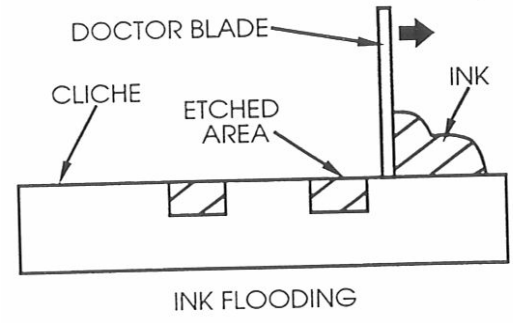
G. Permanent Decoration-Pad Transfer printing ink has excellent adhesion to a variety of substrates, as well as abrasion resistance.

Pad Transfer Printing Theory

PAD TRANSFER PRINTING THEORY

Step 1-Ink Flooding

The image to be transferred to the substrate is etched into a steel or nylon plate, commonly referred to as the cliche. The entire top surface of the cliche, which is mounted in the inkwell, is flooded with ink by the flood bar. A stainless steel doctor blade then wipes the excess ink from the cliche surface, leaving ink only in the etched areas.

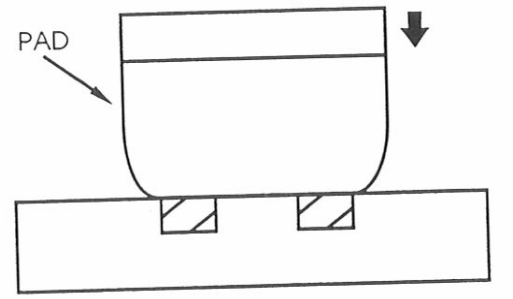


INK FLOODING

After the cliche is wiped by the doctor blade, the surface of the ink in the engraving which is exposed to the air, becomes more viscous and tacky as the solvents evaporate. As this occurs, the ink's ability to adhere to the silicone transfer pad is improved.

Step 2-Pad Wetting

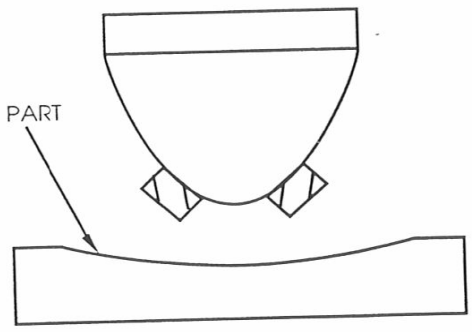
The pad is positioned directly over the cliche, pressed onto it to pick up the ink, and then lifted away. The physical changes in the ink that take place during flooding (and wiping) combined with the high surface tension of the silicone pad, account for the ink's ability to leave the recessed engraving in favor of the pad.



PAD WETTING

Step 3-Head Stroke

After the pad has lifted away from the cliche to its complete vertical height, there is a delay before the ink is deposited on the substrate. During this stage, the ink has just enough adhesion to stick to the pad (it can be easily wiped off, yet it does not drip). The ink on the pad surface once again undergoes physical changes: solvents evaporate from the outer ink layer, that is exposed to the atmosphere, making it more tacky and viscous. Solvents on the inner surface migrate toward the pad, reducing the pad/ink adhesion.

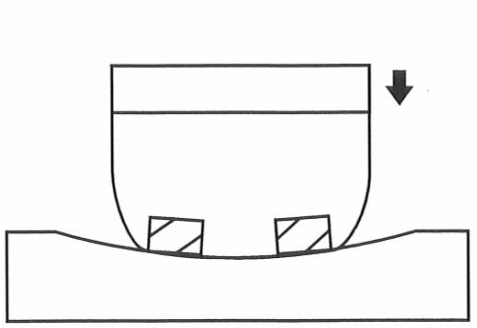


HEAD STROKE

PAD PRINTING THEORY (cont'd.)

Step 4-Ink Deposition

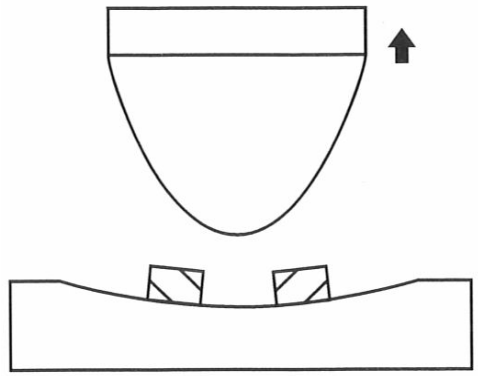
The pad is pressed down onto the substrate, conforming to its shape and depositing the ink in the desired location, Even though it compresses considerably during this step, the contoured pad is designed to roll away from the substrate surface rather than press against it flatly. A properly designed pad, in fact, will never form a 0 degree contact angle with the substrate: such a situation would trap air between the pad and the part, which would prevent ink transfer.



INK DEPOSITION

Step 5-Pad Release

The pad lifts away from the substrate and assumes its original shape again, leaving all of the ink on the substrate. As explained in Step 3, the ink undergoes physical changes during the head stroke and loses its affinity for the pad. When the pad is pressed onto the substrate the adhesion between the ink and the substrate is greater than the adhesion between the ink and pad, resulting in a virtual complete deposition of the ink. This leaves the pad clean and ready for the next print cycle.



PAD RELEASE

Engraved Plate Technology

ENGRAVED PLATE TECHNOLOGY

Perhaps the most importatnt variable in the pad transfer printing process is the engraved plate, which is commonly called the cliche. There are four types of cliches available and the accompanying comparison table will assist you in selecting the proper plate for the printing application.

COMPARISON OF ENGRAVED PLATE OPTIONS

Category	3/8" Steel	Thin Steel	Water Wash	Alcohol Wash
Supplier	United Silicone	United Silicone	① In-House or United Silicone	① In-House or United Silicone
Material	Case-Hardened 0-2 60-62 RC Hardness	② .020" Thick 47-51 RC Hardness	② Nylon with .010" Steel Backing	② Nylon with .010" Steel Backing
Production	Acid-Based Etching	Acid-Based Etching	Water-Based Etching	Alcohol-Based Etching
③ Etch Depth Range	Up to .002"	Up to .002"	Up to .001"	Up to .002"
④ Image Screening	Available	Available	Not Available	Available
⑤ Average Plate Life	500,000 Wipes+	100,000 Wipes	7,500 Wipes	7,500 Wipes
Price	$6.00/In^2 Includes film set-up and etching	$2.50/In^2 Includes film set-up and etching	$.60/In^2 $30 Film Set-up $10 Etching	$.50/In^2 $30 Film Set-up $10 Etching

NOTE: For more information on the numbered items, please see the notes below.

Notes on Engraved Plate Options

1. Nylon plates can be produced in-house with the use of a Model UP 8-16 Plate Maker.
2. For shorter runs the thin steel or nylon cliches are ideal. This type of plate is mounted in the inkwell by using one of two methods listed below. In all cases the steel backing of the cliche is magnetically attached to a back-up plate.

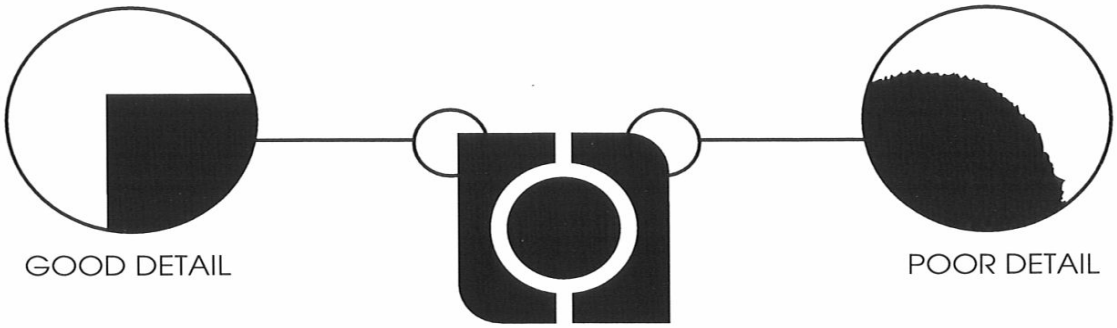
Method A: A piece of magnetic sheet material is placed on top of a ground steel back-up plate.

Method B: Magnetic inserts are placed in the bottom surface of an aluminum back-up plate, or nylon of cliches can be mounted directly in a pre-magnetized quick-change inkwell.

③ Regardless of which plate material is chosen, the most critical element is the etched image, and in particular the following three items:

a. Artwork Quality

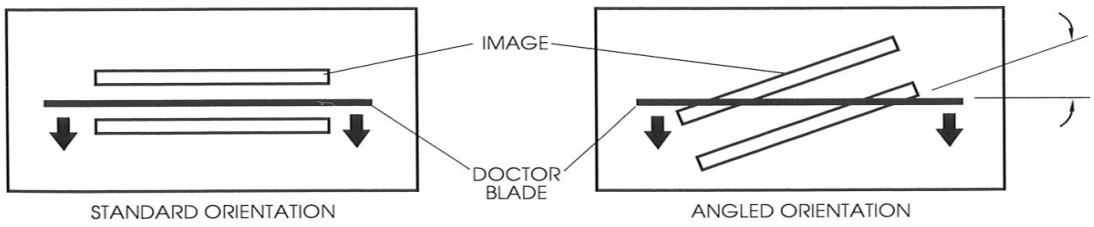
The printed image on the substrate can only be as good as the original artwork. Therefore, if the edges of the graphic are rough on the film, then they will also be ragged on the part. Similarly, for good etching, the film for the mask is of great importance, and the closest attention needs to be paid to its preparation. Also, the stroke width of any part of the image should exceed .003".



b. Image Location

For most applications, the image is centered on the plate and the sides of the graphics run parallel to the edges of the plate. However, graphics with long lines running parallel to the doctor blade must be handled specially or the blade will drop into the image cavity and scoop excess ink. This will reduce the ink thickness and ultimately affect the opacity of the printed image. This problem may be handled in one of two ways:

i. The image can be "screened" (see section 4 on the next page)
ii. The image can be oriented on the plate at an angle so that the doctor blade is supported properly as it passes over the etched graphic. (see below)

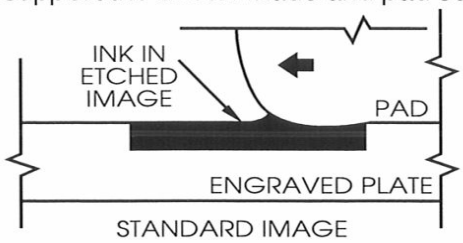


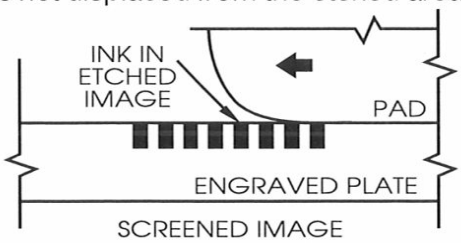
c. Etch Depth

The etch depth depends on the image, and the most common depths are listed in the table below.

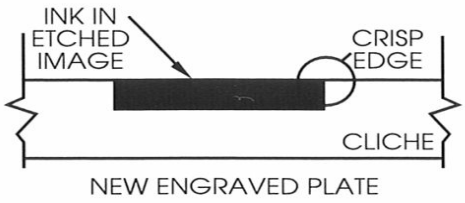
ETCH DEPTH	COMMON APPLICATIONS
.0007"	Graphics with fine detail (Character width is .003" to 1/32")
.0010"	Graphics with normal detail (Character width is 1/32" to 1/4")
.0015" to .0017"	Graphics with large areas (Character width exceeds 1/4" and image is screened)

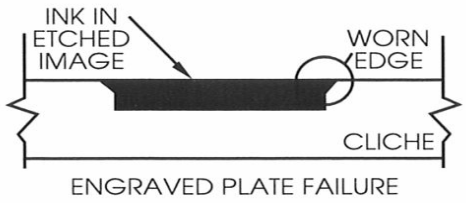
④ With large images, the doctor blade can drop into the etched cavity during wiping and remove too much ink, or the ink may be displaced by the pad at pick-up. Both result in an irregular image when the ink is transferred. To remedy this situation, the artwork is "screened" using one of several dot patterns available. Then, when the plate is etched, the large graphic image is left with projections shaped like small truncated cones. These help support the doctor blade and pad so that ink is not displaced from the etched area.





⑤ The most common symptom for an engraved plate failure is a printed image with details that are not as "crisp" as they once were. This problem results when the top edge of the etched image becomes rounded due to wear and extra ink is left in the cavity, picked-up by the pad, and printed.





Doctor Blade Technology

DOCTOR BLADE TECHNOLOGY

After the entire top surface of the engraved plate is flooded with ink, the doctor blade is the component that actually contacts plate during the wiping stage to remove the excess ink. The configuration of the blade is critical so that satisfactory doctoring is accomplished.

Material: Stainless Steel, with a Rockwell Hardness of 50

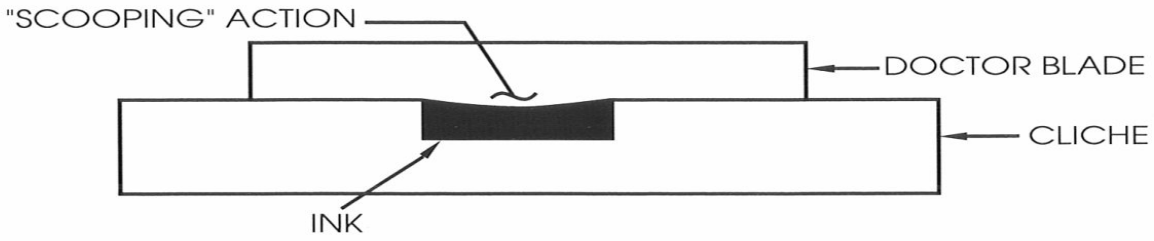
Thickness:

Option A-.008"

This is used in approximately 70% of all applications and can be utilized with steel or nylon cliches.

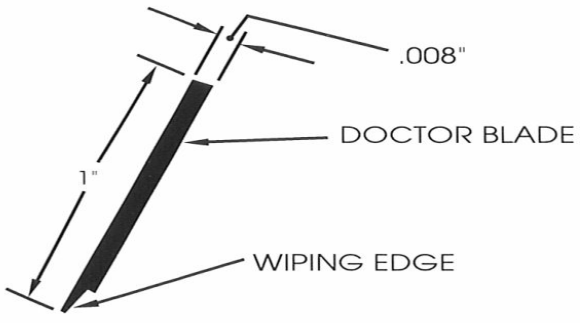
Option B-.020"

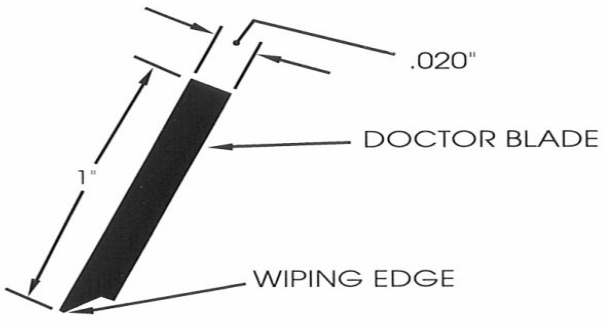
This doctor blade thickness can only be used with steel cliches. The material is more rigid than that described in Option A and its primary use is for bold images. If the stroke width of any graphical exceeds 1/4", and the image is not screened (see engraved plate technology), then .020" thick material should be used. With this configuration, the doctor blade is less likely to flex under the pressure of the wiping stroke and scoop excess ink from the engraved image.



Design Considerations:

The beveled area actually contacts the cliche. This wiping edge is chemically etched instead of ground, so that the contact surface is as smooth as possible.





Doctor Blade Life:

When installing a new doctor blade, the beveled wiping edge should be wiped with a “Scotch-Brite” pad. This cleasn and polishes the contact surface of the blade to aid in satisfactory doctoring. The life of the blade will be increase if the doctor blade holder assembly is positioned so that the cliche is wiped with a minimum amount of pressure.

The doctor blade should be replaced when ink streaking on the cliche cannot be eliminated with minor adjustments to the doctor blade holder. THis is an indication of one of two things:

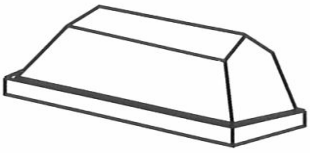
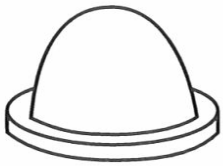
1. The wiping edge of the doctor blade had been damaged, away.

Transfer Pad Technology

TRANSFER PAD TECHNOLOGY

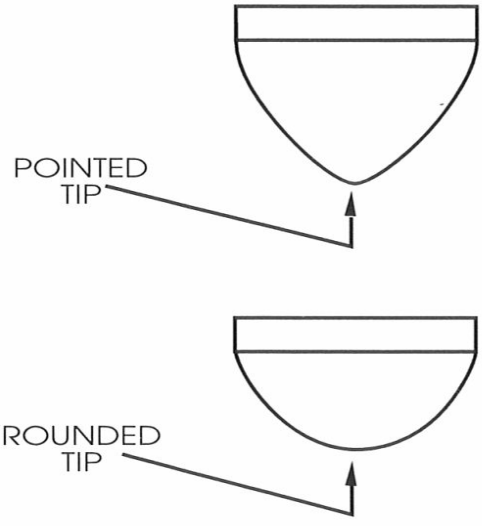
Silicone rubber transfer pads are available in an assortment of standard shapes, angles, thickness, sizes, hardness, and pad base materials that are determined entirely by the characteristics of the decorating surface and the design to be printed.

A. Shapes

Title	Application	Example
Roof -Top	Line copy printing on a relatively flat part	
Round	Circular copy printing on flat or contoured parts	
Half-Moon	Mixture of line and circular copy printing on flat or contoured parts	

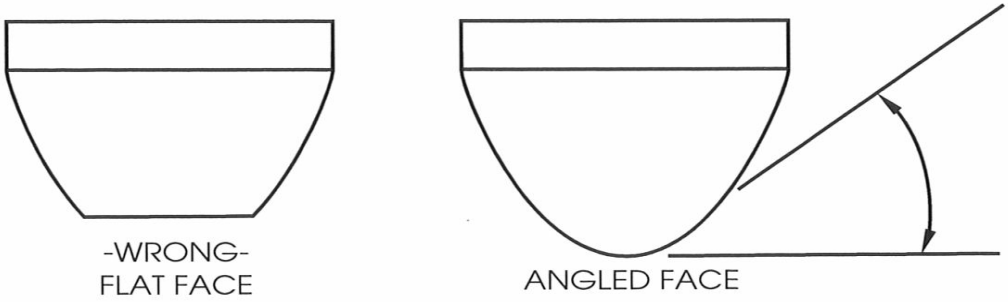
In addition to the overall shape of the transfer pad, the "Tip" of the pad is also critical. There are two standard options:

1. Pointed Tip - This is the most common shape, and the tip should not contact any part of the graphic when ink is picked-up from the engraved plate. If it does, the pad will likely displace ink which leads to a void in the printed image.
2. Rounded Tip - For larger solid graphics, when pad tip contact with the image area cannot be avoided, a rounded shape should be used.The gentle contour results in less pad compression and therefore the chance of ink displacement is minimized in the pick-up and printing positions.



B. Angles

The pad acts as a transfer mechanism to move ink from the printing plate to the part being printed. In order to do this, the pad should create a "rolling" effect when it is compressed onto the printing plate, not a blotting action which can trap air. To accomplish this, the face of the printing pad needs to be angled rather than flat.



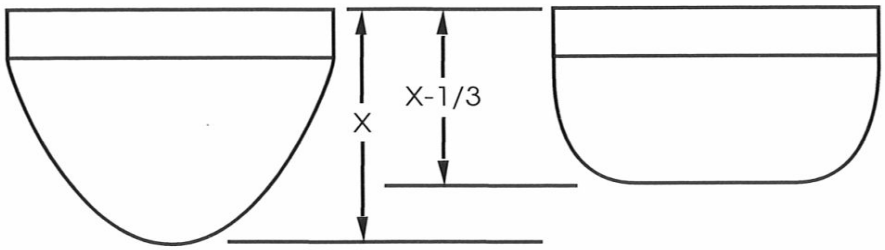
-WRONG-
FLAT FACE

ANGLED FACE

The most common angles are 30, 45, and 60 degrees. The smaller the image, the higher the angle should be so that there is more time for air to escape from the image as the pad is compressing and rolling. On the other hand, the more contour the part surface has, the smaller the angle should be so that there is less compression required to completely cover the surface.

C. Thickness

The pad thickness, or height, should be chosen so that during ink pick-up and printing the pad never compresses more than 1/3 of its total thickness. By following this rule of thumb, the bond life between the silicone rubber and the base will be maximized. Furthermore, over-compression squeezes silicone oil from the pad which will, over time, deter the proper release of the ink from the surface.



NATURAL PAD SHAPE

COMPRESSED PAD SHAPE

D. Sizes

When checking the printing size of the pad, you should remember that a pad with more mass will tend to give less print distortion than a pad that is just big enough to fit the image. This is not to say that a smaller pad will always cause print distortion, but a larger one would generally be the best choice.

E. Hardness

Picking the right silicone pad hardness is dependent on the shape and/or texture of the part being decorated and also the image being printed. There are four different hardness options ranging from 65 durometer on the Shore 00 scale to 22 durometer. In general, a harder pad will deliver a "sharper" image and a softer pad will wrap around a contoured part better to allow for greater coverage.

NOTE: 60 durometer, Shore 00 Scale = 12 Durometer, Shore A Scale

Hardness Designation	Durometer Range (00 Scale)	Application
Hard Pad (HP)	60-65	-Fine graphics with up to 1/32" stroke width and/or coarse textured surfaces. Will accommodate a slight crown in the part.
Medium Hard Pad (MHP)	38-45	-Most common hardness. Used for small graphics from 1/32" to 1/4" stroke width, and medium textured surfaces. Will accommodate a slight crown in the part.
Medium Pad (MP)	28-35	-Bold graphics or reversed images on flat parts. Also used for regular graphics in excess of 1/4" stroke width on a contoured part.
Soft Pad (SP)	22-27	-Regular graphics, in excess of 1/4" stroke width, on a part with a tight contour.

F. Pad Base Materials

Bases for bonding silicone rubber pads are commonly made from wood but aluminum is used for high tolerance mounting applications. Wood bases are constructed from a very good grade of 5/8" thick marine plywood and a metal threaded insert is pressed into the center of the back of the base for mounting purposes.

Aluminum should be used when the location of the drilled and tapped mounting hole in the base is extremely critical. Otherwise, wood is the material of choice because the silicone bonds better to it since it is more porous than aluminum, and wood will not oxidize.

NOTE: To help maximize the life of a pad, it should be stored in an enclosed cabinet to minimze exposure to dust and other potential contaminates. The ideal storage temperature is 50°F - 70°F and the pad should sit on its base to deter the migration of silicone oil to the surface.

COMMON CAUSES FOR PAD FAILURE	
Symptom	Cause
	Sharp part edges are the most common causes of cutting and tearing.
Some ink is retained on the pad after printing.	Too much exposure to solvents through excessive cleaning, etc. will extract the silicone oils from the surface of the pad.
Some ink is retained on the pad after printing.	Over compression of the pad will squeeze silicone oils from the surface of the pad.
Delamination at the bond line between the silicone rubber and the base of the pad.	Over compression of the pad. Make sure that the silicone does not compress more than 1/3 of its total thickness.
Delamination at the bond line between the silicone rubber and the base of the pad.	Part decorating surface is not presented as parallel as possible to the engraved plate causing the pad to skid as it compresses.

Ink Technology

INK TECHNOLOGY

In order to achieve optimum printing results, it is essential to use special pad printing inks. These inks are airomatic in that they cure by evaporation and they feature extremely high pigmentation levels since only a slight amount of ink is transferred during the process. Standard colors are available and custom colors can be specified.

Ink Chemistry

Pad transfer printing inks are made from different binders, pigments, fillers and additives; plus an assortment of auxiliaries such as thinners, retarders, and hardeners to provide for easy ink processing. By selecting from the components mentioned above, the ink will be tailored to a specific application and will only adhere to a specific family of substrates.

Binders -	Made from resins and dissolved in solvents
Pigments -	Responsible for the color shade of an ink
Fillers -	Promote certain properties such as opacity, viscosity and abrasion resistance in an ink.
Thinners -	Mixed in the proper amount with the ink, thinners are used strictly as a means for "transporting" the ink from the engraved plate to the part by changing the viscosity.
Retarders -	Mixed in the proper amount with the ink, retarders are used to slow the evaporation of the thinner. These are rarely used but are extremely beneficial on humid days.
Hardeners -	Mixed in the proper amount with the ink, hardeners are used as a catalyst to help harden the outer skin of ink to promote improved abrasion resistance.

Ink Technology

United Silicone pad transfer printing inks are categorized by the number of components they contain. Single component ink is adjusted, prior to printing, to the proper viscosity by adding thinner. For enhanced abrasion resistance, hardener is mixed with thinner and the ink in a two component format.

The consistency of pad transfer printing ink constantly changes. After mixing, single-component inks have considerable longevity as long as they are maintained properly, either manually or automatically. On the other hand, two-component inks have a “pot life” and will become too viscous within 8 hours. After printing, all ink types dry to the touch quickly, and this can even be accelerated by directing heated forced air across the graphics. Finally, when an ink fully cures, all solvents have evaporated, optimum adhesion to the substrate has been obtained, and physical testing can be conducted.

Number of Components	Single-Component	Two-Component
Ink Systems	UP20, UP30, *UP46, *UP 401, *UP 407	*UP46, *UP82, UP82GL, *UP85, & *UP87
Standard Formulation	Base ink is reduced by weight with at least 10-15% thinner	Base ink is mixed with hardener in the ratio indicated below, then reduced by weight with at least 10-15% thinner -UP46, & UP87 — 10:1 ratio -UP82 — 5:1 ratio -UP82GL — 20:1 ratio -UP85 — 8:1 ratio
Performance	Quick setting with good opacity and adhesion	Quick setting with good opacity, adhesion and abrasion resistance
Suggested Substrates	See next page	See next page
Drying Time	Within 30 seconds	Within 30 seconds
Curing Time	Approximately 72 hours	Approximately 72 hours

*Non-toxic ink with reduced metal level

Ink Selection

When the printing substrate is known, an ink selection chart can aid in proper ink type selection. Sometimes there is more than one ink type for a specific substrate and a test should be conducted to determine compatability. Also, it is important to remember that thermoset materials and substrates from the polyolefin family (Polyethylene and Polypropylene) must usually be pre-treated to obtain good adhesion. For reference, please see the guide on the next page.

INK SELECTION GUIDE

Substrate	Ink Product Number								
Thermoplastics	**UP 20**	**UP 30**	**◇UP 46**	**◇UP 401**	**◇UP 407**	**◇UP 82**	**UP 82GL**	**◇UP 85**	**◇UP 87**
ABS (Acrylonitrile-Butadiene-Styrene)				X	X	X		X	
Acetal						X**		X**	
Acrylic			X	X	X	X		X	
Cellulosic (Cellulose acetate/butyrate)		X	X	X	X	X		X	
Polyamid (Nylon)						X**			
Polycarbonate		X	X	X	X	X			
Polyester		X				X		X	
Polyethylene			X*	X*	X*	X*		X*	
Polypropylene	X		X*	X*	X*	X*		X*	
Polystyrene		X		X	X	X		X	
PVC - Plasticized (Polyvinyl Chloride)								X	
PVC - Rigid (Polyvinyl Chloride)			X	X	X			X	
SAN (Styrene - Acrylonitrile)			X	X	X	X		X	
Thermosets									
Epoxy/Epoxy Coating			X			X			
Phenolic						X		X	X
Polyurethane		X				X		X	
Rubber									X
Miscellaneous									
Ceramic						X***			
Paint Coating		X	X	X	X	X		X	
Glass							X	X	
Leather		X	X	X	X	X			X
Metal						X	X	X	
Paper		X	X	X	X				
UV Coating						X			
Wood			X	X	X	X		X	

* Substrate must be pre-treated
**Substrate must be post-treated
***Substrate must be printed after firing

◇ - Indicates non-toxic ink with reduced metal level

Information provided is based upon tests and considered reliable. Since operating conditions and applications are beyond our control. United Silicone Inc. can not guarantee results or assume liability for any problems that may arise. The user should test the suitability of the product for its intended application. We can not assume warranty for results obtained, expressed or implied.

Notes:
1. Physical testing of ink should not be performed until 72 hours have elapsed after printing.
2. After printing, the use of heated forced air only speeds solvent evaporation from the ink. It does not improve the adhesion of the ink to the substrate.

Part Holding Fixture Technology

PART HOLDING FIXTURE TECHNOLOGY

The final component of the pad transfer printing "tooling" is the part holding fixture that registers the substrate and holds it in place throughout the print cycle.

Our production expertise includes pattern making, duplicating, engraving, and conventional machining. Fixturing components are produced in a variety of materials including aluminum, a range of rigid and resilient casting compounds, nylon, teflon and PVC.

Tooling design can be deceptively simple. As the following example indicates, many parameters exist even for relatively simple applications. No matter what kind of part is involved, the following steps are always used when building a custom part holding fixture.

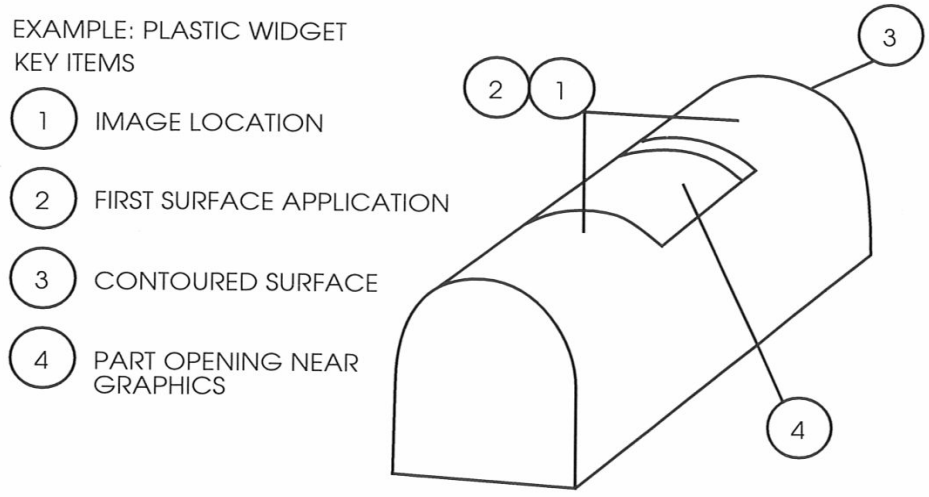
1. Evaluate the part
2. Build the part holding fixture

Please see the information below for a discussion of both of the steps listed above.

Step 1 – Evaluate the Part

- Part Material
- Image Size
- 1st or 2nd Surface Application
- Flat or Contoured Surface
- Smooth or Textured Surface
- Openings in the part near the graphics
- Numbers of Cavities in Mold

  When multiple cavities are involved, and the part consistency is poor then a dimensional analysis is performed. A "median" part is chosen to develop the tooling.



Step 2 – Build the Part Holding Fixture

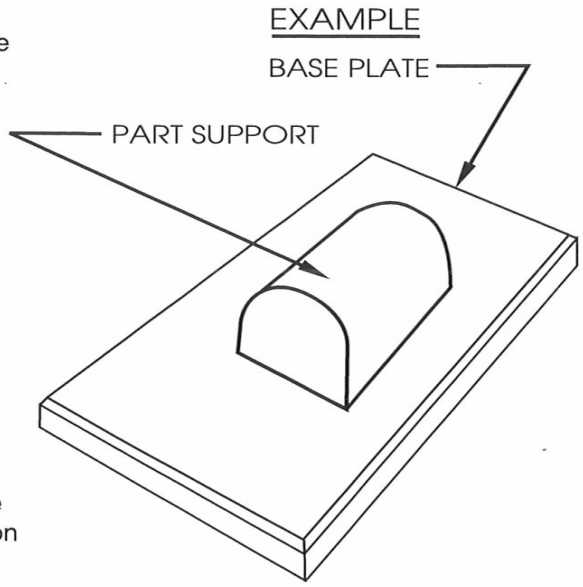
Key Elements:

1. The decorating surface should be presented as parallel as possible to the cliche surface.
2. The fixture should "hold" the part firmly in place throughout the print cycle, and it should be designed so that part-to-part location is consistent.
3. Support behind the decorating surface is not mandatory for smaller image applications as long as the part is rigid enough. However, for bolder/large graphics or textured surfaces, where extra pressure is required, the part should be supported.
4. The various components of the fixture are constructed directly from the parts, not from a part print.

Base Plate Material

For part holding fixture base plates, aluminum is used most often as opposed to steel:

1. Lighter than steel, easier to handle
2. Easy to machine
3. Will not rust
4. Durable



Part Support Materials

A. Aluminum - Same arguments as above

B. PVC - Machined to the part configuration

1. Won't scuff clear plastics or substrates with a high gloss finish
2. Not as durable as aluminum

C. Nylon or Teflon -

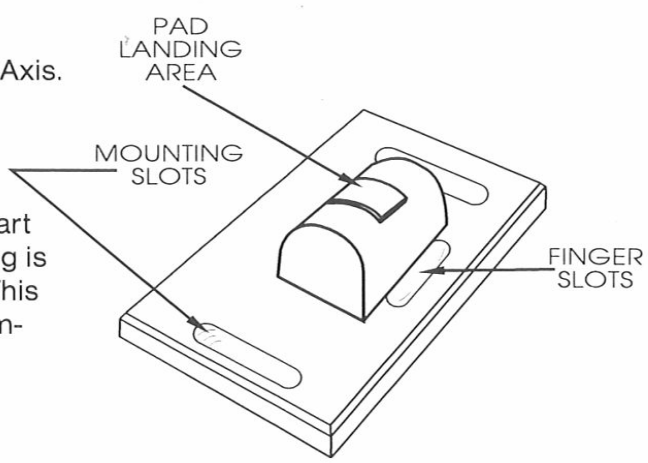
1. Won't scuff plastics
2. Ideal for automatic part discharge applications because of low friction
3. Not as durable as aluminum

D. Cast Urethane - A coating of Urethane is bonded to a metal base, ideal for contoured applications

1. Provides tighter fit than aluminum, PVC, Nylon, or Teflon since Urethane is cast directly from the part
2. Not as durable as aluminum

Common Part Holding Fixture Options

1. Mounting slots for adjustment in the Y-Axis. (X-Axis adjustments are made by utilizing the "T" slots in the table base.
2. Finger slots to grasp the part easier
3. Pad landing area for openings in the part that are near graphic areas. The landing is at the same level as the part surface. This supports the pad during printing to eliminate pad stretching which can lead to image distortion.



Printing Troubleshooting

PRINTING TROUBLESHOOTING		
Problem	Cause	Remedy
Voids and/or variable opacityy in printed image with no ink retained on the pad surface.	-Pad is not broken-in and ideal amount of silicone oil is not present on the pad surface. -Ink is too “dry” (thick) and is remaining in engraved cavity on cliche. -Ink is dieplaced from the engraved cavity of cliche due to excessive doctor blade wiping pressure. -Ink is displaced from the engraved cavity of cliche due to shallow depth.	-Compress the pad approximately 50 times to extract oil. -Add thinner to the ink a little at a time. -Reduce doctor blade wiping pressure. -Engrave image cavity of the cliche to a greater depth.
Void in printed image image with some ink retained on the pad surface.	-Ink is too”wet” (thin). -Pad failure, there are no silicone oils on the surface to aid the release of ink.	-Use pad delay and/or more ink to inkwell. -Replace the pad, and make sure compression is no more than 1/3 of its total thickness.
“Pin hole” size voids in the printed image with no ink retained on the pad.	-Entrapped air during ink pick-up.	-Reposition pad point so contact with image area is eliminated and/or choose pas with alrger contct angle.

TROUBLESHOOTING (cont.)		
Problem	Cause	Remedy
“Hairy” image	-Static charge -Ink is too “dry” (thick) -Image cavity on engraved plate is too deep.	-Us estatic eliminator on pad or in ink. -Add thinner to the ink a little at a time. -Engrave image cavity of the cliche to a greater depth.
Blurry image	-Ink is too”wet” (thin). -Pad is compressed too much and/or undersized. -Part moves between first and second print on a double hit application.	-Use pad delay and/or more ink to inkwell. -Reduce pad compression to no more than 1/3 of total thickness and/or utilize larger pad. -Redesign the holding fixture to locate the part better.
Distorted image	-Pad is compressed too much and/or undersized. -Insufficient pad support in part holding fixture.	-Reduce pad compression to no more than 1/3 of total thickness and/or utilize larger pad. -Add pad support to fixture in part openings and/or around part perimeter if pad wraps over edge.