# Molding Materials and Process Troubleshooting

LESSON 5: Surface Defects

# Lesson 5: Surface Defects

Surface defects are usually caused by under-packing the part, or problems with the melt temperature. If the melt is too cold it will not flow well through the gates. Sections of the melt can cool and solidify before they should. If the melt is overheated it can bum and leave charred particles in the flow. This lesson will discuss how parts are under-packed, and some of the most common surface defects.

# Objectives of Lesson 5

1. Learn about burn marks
2. Learn about black specs and streaks
3. Learn about contamination and discoloration
4. Learn about dull surfaces, glossy surfaces, haze and clear spots
5. Learn about surface disturbances at the gate
6. Learn about splay
7. Learn about blisters and delamination

# Objective One

### Burn Marks

Burn marks are small black sections on the part surface. Burn marks are usually black or dark brown. Burning the plastic, or compressing and igniting trapped air (gases), are the two most likely causes.

### Trapped Air (Gases)

Burn marks usually occur at the end of the flow path. When air is trapped in the melt or in the cavity, it can be compressed and overheated, and actually ignite the plastic leaving black marks on the part surface.

There are a number of ways air or other gases can be trapped in the melt. Poor venting will mean that the air in the cavity does not escape as it should. Excessive injection pressure or injection speed can inject the melt too quickly. The extra speed can create turbulence. The broken melt front can trap air in small pockets in the melt. If the air is then overheated, it can be compressed and ignite the plastic leaving burn marks.

### Burned Plastic

Overheating the plastic may also cause bum marks such as those in Figure 1. Excessive barrel temperature can easily degrade the plastic. If the plastic spends too long in the barrel before injection, it can also burn. Slow screw speed or high back pressure can keep the plastic in the barrel too long.  The screw shears the melt longer, raising the temperature.

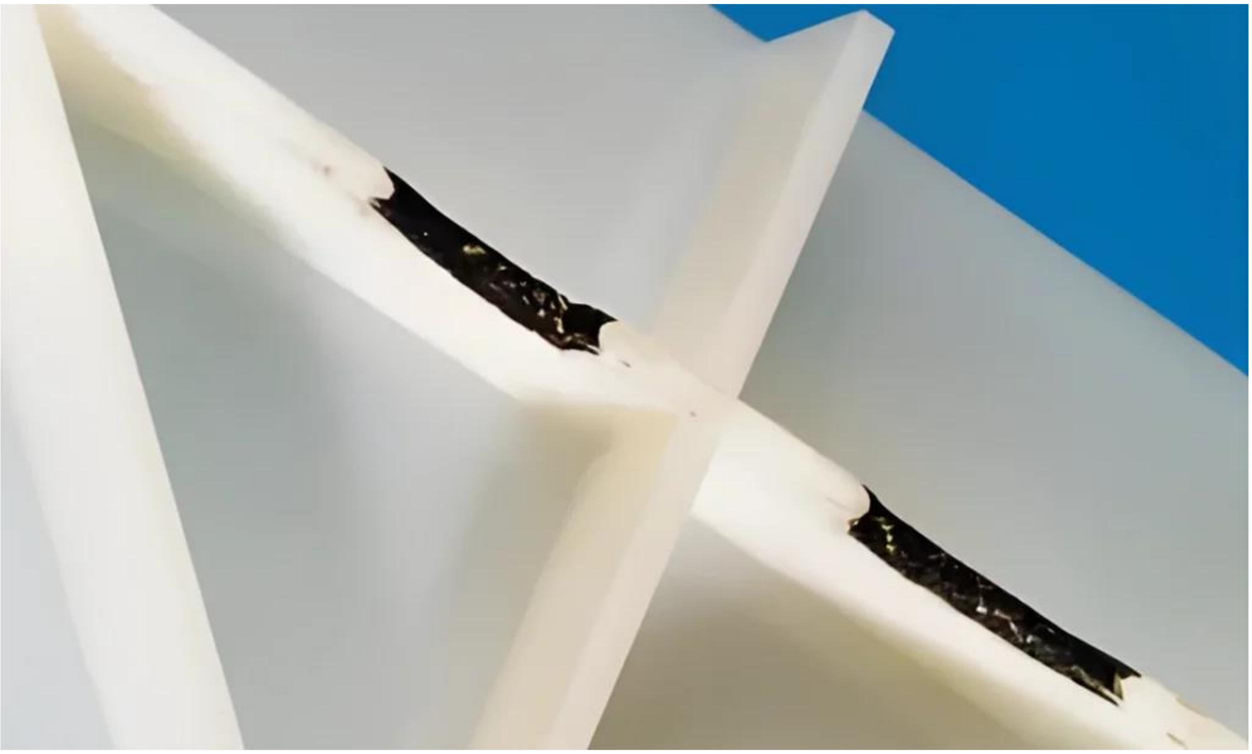

*Figure 1 - Burn Marks*

# Exercise One

## Burn Marks

Locate a part with burn marks on it, or take a part and label the areas where you would suspect burn marks to occur. Make a sketch of the part, and label the gate, burn marks and vent locations.

| Part Number | Gate | Burn or Potential |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

Instructor Date

# Objective Two

## Black Specks and Black Streaks

### Black Specks

Black specks are small, dark particles on the surface of the part (Figure 2). Black specks are usually caused by smaller bits of plastic that have lodged somewhere in the machine and burned. Later, they break loose in the melt and cause black specks. There are many places in the machine where small bits of plastic material can lodge, overheat, and burn. Nicks, cracks, scratches, and pits in the barrel, runners, or screw can easily trap small bits of plastic long enough to burn them.

*Figure 2 - Black Specs*

**Black Streaks**

Black streaks are usually caused by plastic burning in the barrel. If the screw tip, or check ring, is cracked, the plastic that passes by it can be over-sheared. This material may bum from friction. The burnt plastic pellets forms black streaks when mixed into the melt.

Black specks and streaks can be caused by problems in the heating systems. Any problem in the barrel heaters, thermocouples, or controllers can cause uneven heating. If a thermocouple fails, or a heater band comes loose, the other heater bands may try to compensate. This can make the temperature too high at some spots in the barrel.

The higher band temperatures can burn part of the melt. This burnt melt will char, and mix with the injected melt to cause black specks or streaks. Black specks and streaks can also be caused by contamination. Mold lubricants and grease can work their way into the vents. When the vents clog, air is trapped in the cavity and burned. The burnt air pockets show up as black specks or streaks in the part.

# Exercise Two

## Black Specks and Streaks

Black specks and black streaks are two common defects. Which jobs in your shop are most commonly affected by this problem? What guidelines does your shop have to limit these problems?

| Job/Material Effected | Guidelines to Limit this Problem |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

Instructor Date

# Objective Three

## Contamination and Discoloration

### Contamination

Contamination is any kind of visible defect caused by a foreign substance. In the typical molding shop, there are many things that can find their way into the melt and ultimately into the part. Mold lubricants can easily drip from the cores, slides, and pins and leak into the cavity. Figure 3 shows defects caused by contaminated plastic.

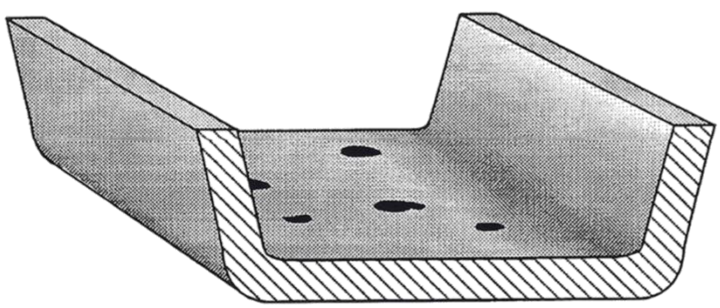

*Figure 3 - Defects Caused by Contamination*

Bad regrind is another likely source of contamination. It is very easy for regrind to pick up all kinds of contaminants. Virgin resin is usually carefully produced, controlled, and fed into the hopper. Regrind, however, does not receive the same attention to purity as manufactured pellets. Regrind can pick up foreign substances during transport to and from the grinders, or during the actual grinding. Pay particular attention to cleanliness when working with regrind.

To eliminate contamination, first shut off the source of the contamination. This may mean closing the hopper lid to keep out dirt, fixing an oil leak, or cleaning up excess lubricant. The next step is to purge out the contaminated material and replace it with clean pellets.

**Discoloration**

Discoloration is any general change in the original color of the plastic material. Discoloration can be caused by many things. Contamination, overheating, or chemical attack are the most likely causes.

Sometimes contamination is so well mixed in that it causes an overall change in the color of the melt. Usually the melt needs to be completely purged from the barrel and the process started over again.

General overheating can also cause discoloration. Melt overheats because of high barrel temperature or excessive shearing during screw plasticizing.

Plasticizing occurs when the screw recovers in the barrel. As it moves backwards, the screw turns, mixing and melting plastic in the barrel. If the melt spends too long in the barrel, the shearing forces of the recovering screw can overheat it to the point of discoloration. Figure 4 shows a discolored molded part.

*Figure 4 - Discolored Parts*

# Objective Four

## Dull Surface, Haze, and Clear Spots

### Dull Surfaces

Some parts do not come out of the mold with the correct amount of gloss on the surface. These parts seem much duller on the surface than they should be. Figure 5 shows the effect of fill speed creating a dull and shiny finish on a part.

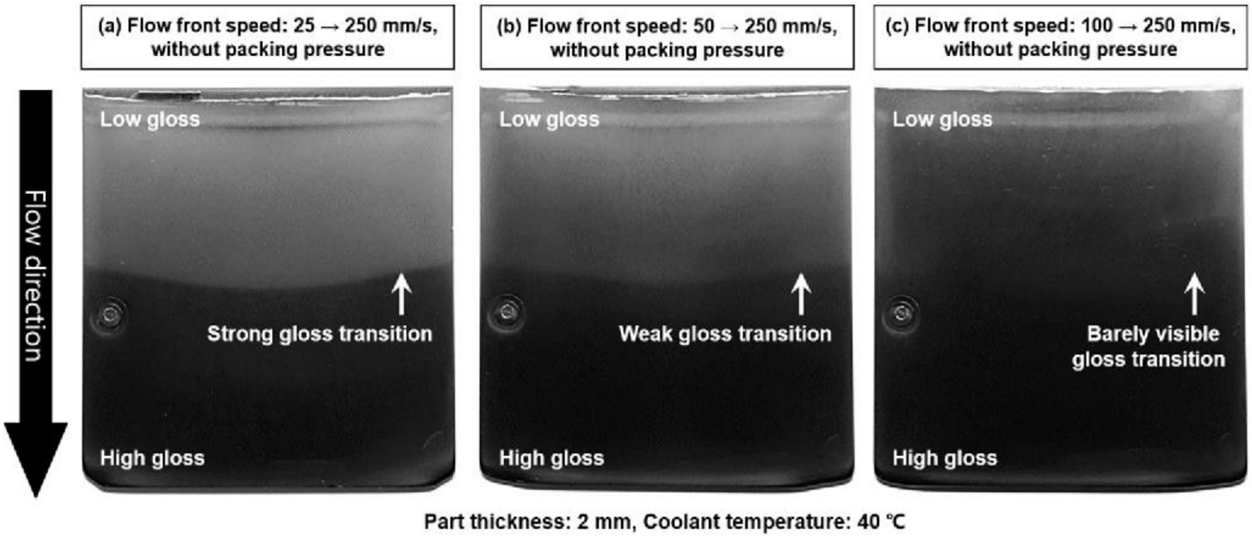


*Figure 5 - Injection Velocity Effect on Gloss*

Problems with general surface finish are usually caused by not packing the part firmly against the cavity walls. If injection pressure or injection speed are too low, there may not be enough pressure on the melt to press it firmly against the cavity walls. The surface skin of the part will not mold to the smooth, polished surfaces inside the cavity.

Another possibility is that the melt temperature is too low. Lower melt temperature makes the plastic thicker, and more resistant to flow. Slow flowing plastic is harder to press and pack tightly into the cavity. The melt temperature might be too low because the barrel temperature or the back pressure is too low.

It is also possible that mold temperature is keeping the part from packing firmly. If the mold temperature is too low, the plastic can skin and solidify before it is packed tightly inside the mold.

If the packing seems fine, examine the cavity surface. It is possible the surface has become dull or pitted. The plastic part cannot be any smoother or glossier than the cavity walls. Damaged or dull walls will make a dull part finish.

**Haze**

Haze is simply a cloudy or milky area on a transparent part. The most likely causes are poorly mixed plastic material or contaminated plastic.

If the plastic is contaminated, put a stop to the source of the contamination, then purge and start over with good melt. For poorly mixed plastic, look for ways to improve the mixing action in the barrel.

Plastic pellets mix in the barrel during screw recovery. The longer the plastic pellets spend in the barrel, the better they will be mixed and melted. You can increase the time the plastic spends in the barrel by increasing the back pressure.

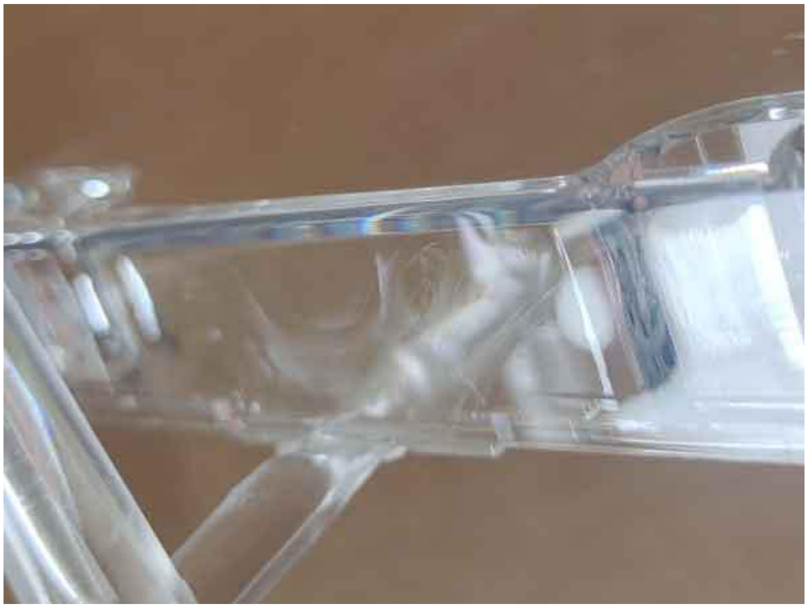

*Figure 6 - Haze Defect*

Higher back pressure adds more shear heat to the melt. Rotating the screw faster will also improve the mixing action in the barrel. Plastic also mixes better when it is warmer. Increasing the barrel temperature will warm the plastic so it mixes better. Figure 6 illustrates a transparent part with a haze defect.

**Clear Spots**

Clear spots are transparent areas in the part. They are caused by un-mixed plastic, or colorant that was not spread through the plastic properly. Improving the mixing activity in the barrel is a matter of increasing the temperature, letting the melt spend more time under the screw, or speeding up the screw rotation.

Regrind is another source of poorly mixed resin. Regrind pellets are usually not as uniform as virgin melt pellets from a major supplier. When the pellets are not all the same size, the larger pellets may not mix and melt as well. Reducing regrind will sometimes help eliminate problems with clear spots, haze, and dull surf ace finish.

# Exercise Three

## Surface Defects

Locate several parts with surface finish defects. De-scribe the defects and list possible molding solutions.

| Part Name | Defect | Solution |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Instructor Date

# Objective Five

## Surface Disturbances at the Gate

Disturbances at the gate happen when the melt front is broken, and one part of the melt cools at a different rate than the rest of the melt.

### Flow Lines

Flow lines are ripples or lines on the part surface that follow the direction of the flow of melt into the cavity. Under-packed parts will often show flow lines. If the part does not pack tightly against the cavity wall, the skin of the melt will solidify in the shape of the flow.

Low pressures and temperatures tend to under-pack the part. If injection speed is too low, the melt will not be injected fast enough into the cavity. Likewise, if melt temperature is too low, sections of the melt will cool and solidify before the cavity is completely full. You can raise melt temperature by increasing the barrel temperature or increasing the back pressure.

If injection pressures and melt temperature look all right, examine the mold temperature. A cool mold will solidify sections of the melt faster than a hot mold. Increasing mold temperature can help eliminate flow lines. Figure 7 shows a part with flow lines.

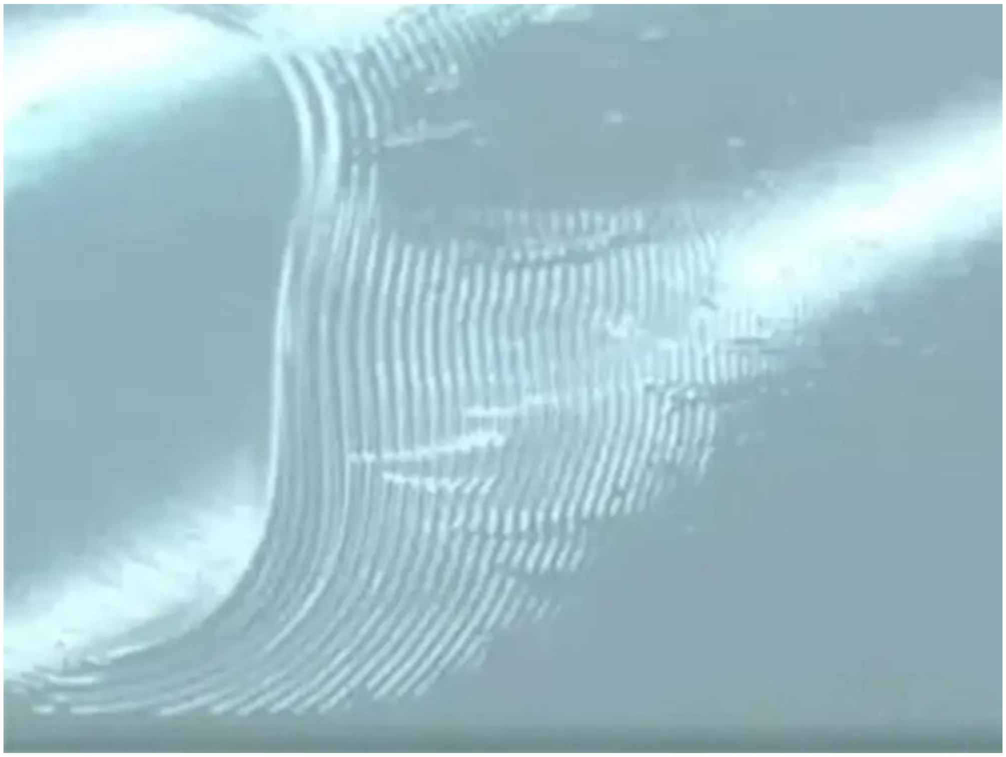

*Figure 7 - Flow Lines*

## Blush

Blush is discoloration on the part at the gates, or other obstruc-tions in the flow path, as shown in Figure 8. The discolored area is usually very weak and poorly packed. Blush is often accompa-nied by splay, or silver streaking. Blush is actually a small, under packed section of a part.

At first, the causes of blush seem contradictory. Blush can be caused by low injection pressure, or high injection speed. The melt temperature might be too high or too low. Either can cause blush. The important thing to remember is blush is a local under packing near the gates or some other obstruction in the part.

If injection speed is too fast, the melt may rush through the gates. The melt surface will skin and begin to solidify before the part is completely packed. In this case, even though the rest of the part may be correctly packed, the skin or surface of the part will not be pressed out against the cavity walls near the gate. The area near the gate will be under packed.

*Figure 8 - Gate Blush*

Usually injection pressure and injection speed have the same effects on melt flow. In this case, if the injection pressure is too low, the surface of the melt may solidify before the part is completely filled. Since the last plastic to enter the cavity remains near the gate, blush normally occurs near the gates.

Fighting blush is also a matter of finding the correct melt temperature. If the melt temperature is too cold, the surface may solidify before the part is completely packed, just like when the injection pressure is too low.

On the other hand, if the melt temperature is too high, the faster moving melt can skip past the gates just as it does when the injection speed is too high. You can adjust the melt temperature by changing the barrel temperature, the back pressure setting, and the screw rpm.

Like melt temperature, finding the correct mold temperature is an important part of keeping blush from forming. If the mold is too hot, the melt can rush through the gates. If the mold is too cold, the surface may solidify before the part is completely packed. Either could cause under-packing at the gates, thus causing blush.

# Exercise Four

## Defects Near the Gate

Find parts with surface disturbances located near the gate. Describe the defect, and list three possible molding solutions.

| Part Name | Defect | Solution |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Instructor Date

# Objective Six

### Splay

Splay looks like spray or droplets splashed on the surface of the part, as in the illustration in Figure 9. Splay is often called silver streaking. Splay is made from charred bits of plastic that have separated from the melt flow and risen to the surface of the part.

*Figure 9 - Splay*

There are many ways to char plastic unintentionally. If the barrel temperature is too high, some of the plastic can be overheated. The charred bits of plastic can rise to the surface, especially near the gates, forming splay.

It is also possible that air and other gases, or moisture, are trapped in the melt. If the air cannot get out of the melt before injection, it can become overheated and burn. Plastic around the air bubble chars, forming the particles that tum into splay.

There are several ways gases can become trapped in the melt. If screw rpm is too high, the melt can actually be "whipped" with air. Some plastics release gases as a by-product of melting. If there is not enough compression in the barrel, these gases may not be squeezed out before injection. Like air bubbles, other gas bubbles can cause burning, charring part of the melt.

Nozzle problems can also contribute to splay. If the nozzle is too hot, it can bum plastic from overheating. Even if the nozzle is not too hot, if it is too small or obstructed, plastic melt may get hung up in the nozzle. The extra pressure in the nozzle tip can cause overheating due to friction.

To get rid of splay, you must first identify the cause of the charred resin. Afterwards you usually must purge out the old melt until clean melt comes out.

# Exercise Five

## Splay

Splay is a common defect in some shops. Make a list of the jobs and materials where splay is a problem. What guidelines does your shop have to limit this problem?

| Job & Material Affected | Guidelines to Limit this Problem |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

Instructor Date

# Objective Seven

## Blisters and Delamination

### Blisters

Blisters are caused by trapped gases that cannot escape before the surface or skin of the part is formed. Figure 10 shows blisters on a part.

*Figure 10 - Blisters*

There are many ways air and other gases can be trapped in the melt. If the screw rotates too quickly, it can whip air into the melt. Some plastics produce gases when they are overheated. If the gas bubbles do not have a chance to escape, they can be molded into the part. One way to get rid of air and gas bubbles is to keep the back pressure high. Higher back pressure increases the compression on the melt before injection. A bigger squeeze presses air and other gases out of the melt before injection.

Air can also be trapped in the melt due to turbulence. If the injection speed is too fast, the melt front can break, trapping air bubbles along the way. Air bubbles tend to rise toward the surface. If the surface has already solidified, the bubbles will form blisters.

Sometimes, uneven regrind can trap air in the melt. If the regrind is made from unevenly sized particles, and it does not mix well in the barrel, air can be trapped in the mix. Keep regrind percentages within authorized limits.

One way to fight blisters is to raise the mold temperature. In a cold mold, the surface of the part solidifies quickly. Any gases still trapped in the melt will not have a chance to escape. A warmer mold keeps the plastic molten longer. Bubbles can escape before the skin of the part forms.

**Delamination**

Delamination is a separation or layering of a part, as illustrated in Figure 11. Some people call it fish scaling.

Under packed parts let layers of plastic cool at different rates. Layers of plastic that cool at different rates can separate. There are many reasons why a part may be under packed. Low injection pressure often does not pack as much material as possible into the cavity. Or, the injection hold time may be too short. Injection hold time keeps the part under pressure while it solidifies. Without good pressure, layers of plastic can solidify at their own rates.

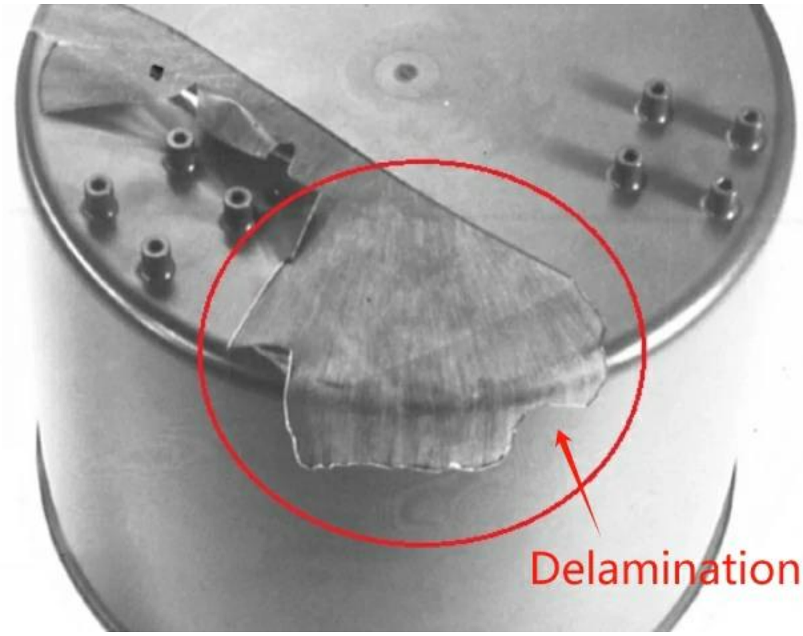


*Figure 11 - Delamination*

Another possibility is that the temperature of the melt is too low. Low melt temperature lets the melt front layer solidify too soon. When different layers of plastic are allowed to cool at their own rates, they tend to separate causing delamination. You can raise the melt temperature by increasing the barrel temperature, in-creasing the screw rpm, or allowing the melt to spend more time in the barrel by increasing the back pressure.

Sometimes mold design is to blame for delamination. If comers in the runner system are not rounded, the melt flow around these comers can separate and begin to cool at different rates.

# Self-Test

1. A likely cause of burn marks is:
    a. Slow injection speed
    b. Low injection pressure
    c. Trapped air
    d. High viscosity
2. Bad regrind is a common cause of:
    a. Burn marks
    b. Splay
    c. Blush
    d. Contamination
3. Dull surfaces are caused by:
    a. Over packing
    b. Excessive injection speed
    c. Under packing
    d. High melt temperatures

4. Haze is usually caused by:
    a. High humidity
    b. Poor housekeeping
    c. Poorly mixed plastic
    d. Contaminated plastic
    e. E, C and D
5. To improve the mixing action in the barrel:
    a. Decrease the screw RPM
    b. Increase the back pressure
    c. Decrease the back pressure
    d. Increase the injection pressure
6. Flow lines are a result of:
    a. High temperatures
    b. High pressures
    c. Low temperatures and pressures
    d. Low viscosity
7. Blush can be caused by:
    a. Low injection speed or high injection speed
    b. Low melt temperature or high melt temperature
    c. Low injection pressure or high injection pressure
    d. All of the above

8. Splay is made from charred bits of plastic.
   a. True
   b. False
9. One way to fight blisters is to:
   a. Increase the mold temperature
   b. Decrease the mold temperature
   c. All of the above
   d. None of the above
10. Delamination can be caused by under packing the part. One way to correct it would be to:
    a. Decrease the back pressure
    b. Decrease the screw RPM
    c. Increase the barrel temperature
    d. Decrease the mold temperature

# Glossary

**Blisters** - bubbles on the surface of the part caused by trapped gases.

**Blush** - discoloration on the part at the gates or other obstructions in the flow path.

**Burn Marks** - small black sections on the part surface caused by burning plastic or ignited air.

**Black Specks or Streaks** - small dark particles or streaks on the surf ace of the part.

**Clear Spots** - transparent imperfections in the part.

**Contamination** - visible defects caused by a foreign substance

**Delamination** - separation or layering of the part. Also called fish-scaling.

**Discoloration** - a general change in the original color of the plastic material.

**Flow Lines** - ripples or lines on the part surface that follow the direction of the melt flow into the cavity.

**Haze** - a cloudy or misty area of the part.

**Splay**- or silver streaking- spray or droplet marks on the surface of the part.