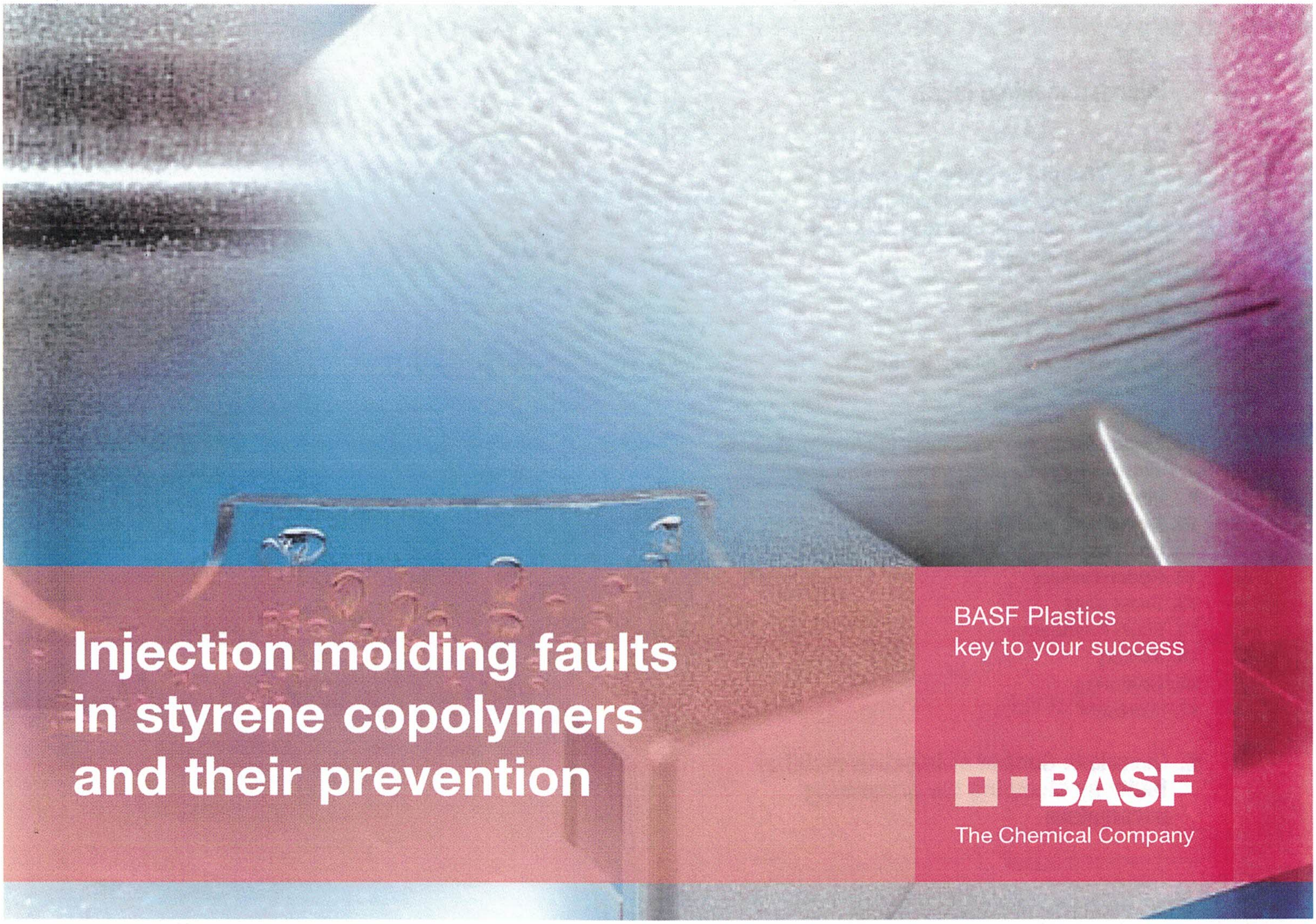

Injection molding faults in styrene copolymers and their prevention

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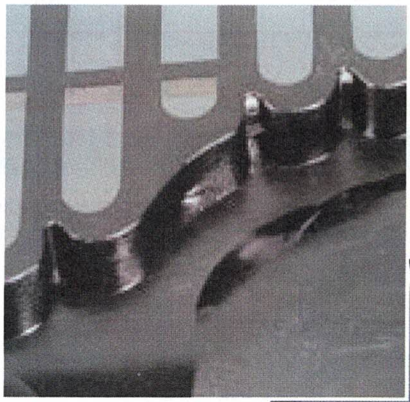
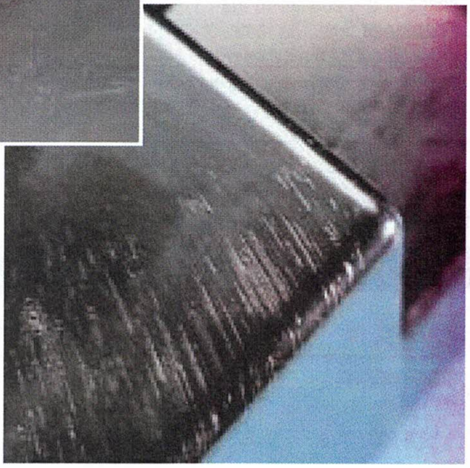
Introduction

Plastic moldings produced by the injection molding process are usually long-lived consumer goods whose suitability for the purpose in question depends not only on the properties of the finished part but also highly on the surface quality. The complex interplay among molding and mold design, processing conditions for the raw material and the parameters for the actual process require a great deal of experience for optimum results especially when focusing on the short-term removal of processing faults. On the basis of an individual case a decision has to be taken as to whether simple and rapid fault correction (by modifying the processing parameters for example) is possible or whether intervention in the design of the parts or the layout of the mold and gating is necessary.

In conclusion the surface faults occurring most commonly in styrene copolymers are noted and described and recommendations for their removal are set out.





I. Injection molding faults

1. Streaks

1.1 Moisture streaks/splay marks

Appearance	Cause	Correction
Usually oblong, silvery surface streaks which are open in the shape of a U counter to the direction of flow. The material pumped out of the cylinder is foamed and shows blisters on the surface.	Moisture content too high; water vapor is produced during melting and this results in the surface of the molding being torn open.	1. Use material adequately predried to a residual moisture content of < 0.1 %. 2. Increase back pressure.

1.2 Burning streaks/silver streaks

Appearance	Cause	Correction
Silvery or dark surface streaks and in exceptional cases black discolorations.	1. Damage to the plastic melt due to excessively high temperatures or overlong residence times resulting from gaseous decomposition products. 2. High shear heating due to small gate cross sections or by sharp changes of direction in the mold.	1. Reduction of the injection speed. 2. Avoidance of undersized gates and sharp changes in direction (shear intensive areas) in the mold. 3. Check the controller of the hot runner system and the barrel heater. 4. Reduction of melt temperature, screw speed (rpm), residence time (if necessary use a smaller plasticizing unit) and back pressure.

1.1 Moisture streaks

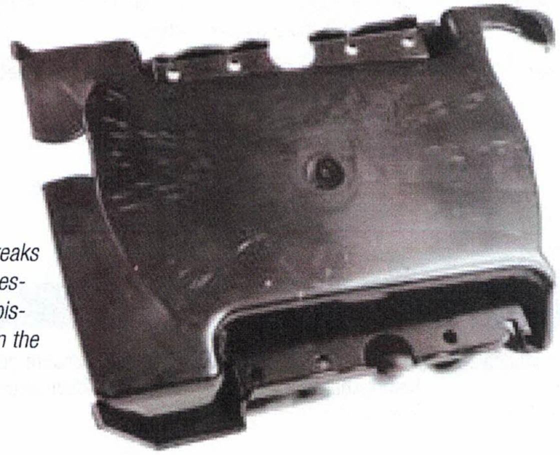


Fig. 1.1.1: Streaks due to an excessively high moisture content in the granules

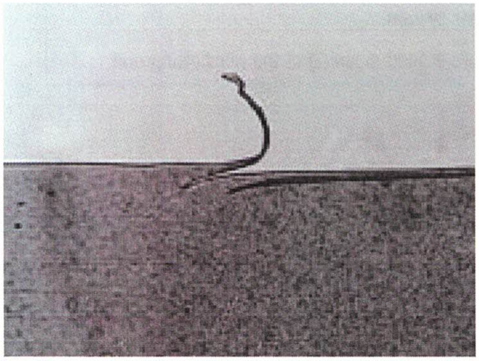


Fig. 1.1.2: Section through a torn streak; transmitted light, magnification 80:1

1.2 Burning streaks

Fig. 1.2.1: Silvery surface streaks

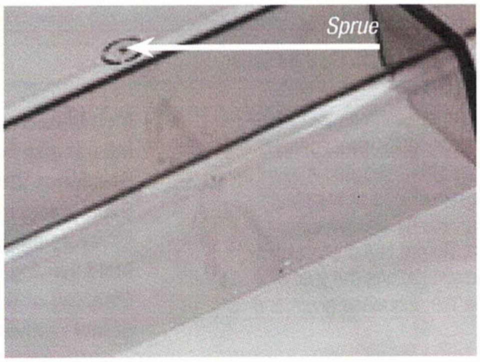


Fig. 1.2.2: Black discolorations on a transparent part

1.3 Dark streaks

Appearance	Cause	Correction
Streaks ranging in color from dark to black	1. Processing using a screw which is too deeply flighted in the feed section (air intake). 2. "Dead spots" in the plasticising unit or hot runner system. 3. Defective nonreturn valve. 4. Screw decompression is too great or too fast.	1. Raise temperature in feed section so that melting is earlier; use more suitable screw. 2. Check plasticizing unit and hot runners for zones of impeded flow and if necessary correct them. 3. Replace defective nonreturn valve. 4. Shorten the path for screw decompression or decompress at a reduced rate.

1.4 Color streaks

Appearance	Cause	Correction
Color differences	1. Inhomogeneous distribution of colorant; accumulations of colorant; unsuitable color batch; alignment/orientation of the usually inorganic pigments by flow processes; thermal pigment damage. 2. "Dead spots" in the plasticising unit or hot runner system. 3. Contamination	1. Use of suitable colorants and batches; ensure good homogenization and dispersion; avoid thermal over-loading. 2. Avoid dead spots in the plasticising unit and in the hot runner system. 3. Make sure a good cleaning of the plasticising unit.

The cause for the formation of streaks can be determined in many cases only after costly investigations, especially as the appearance of burning and moisture streaks is similar. Extensive knowledge of the plastic, the mold design and the processing are indispensable for overcoming the problem. Before launching expensive and time-consuming investigations the following points should be checked in the sequence given and if necessary optimized:

Melt temperature
Injection speed
Residence time in the cylinder
Back pressure
Moisture content of granules
Mold venting
Cleaning of the plasticising unit
Screw recovery speed

1.3 Dark streaks

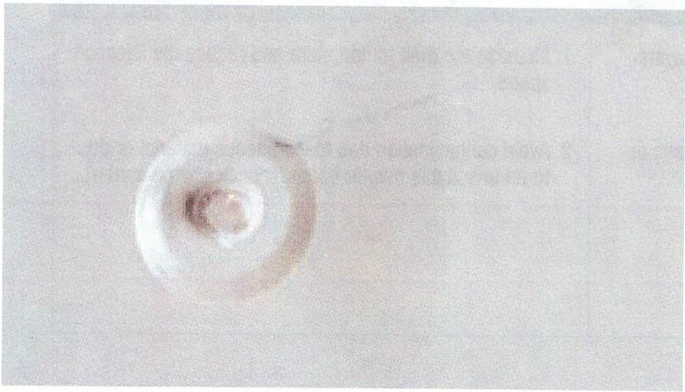


Fig. 1.3.1: Dark streaks caused by deposits of thermally damaged material from the hot runner

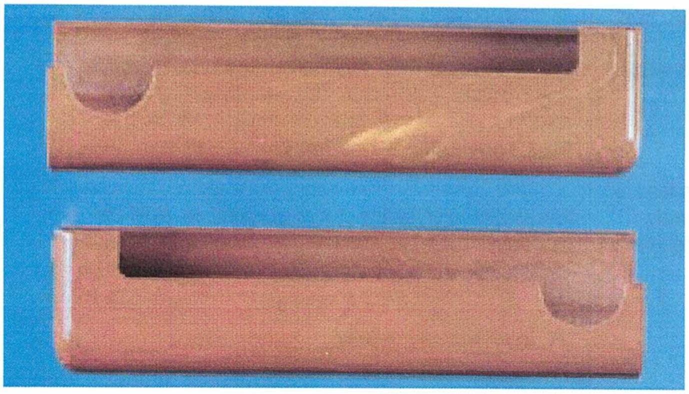


Fig. 1.4.1: Color streaks (inhomogeneous distribution of colorant)

1.4 Color streaks

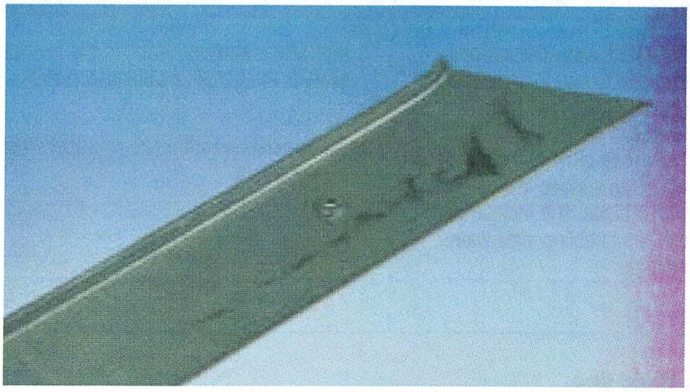


Fig. 1.4.2: Color streaks due to deposits of material due to "dead spots" in a hot runner system

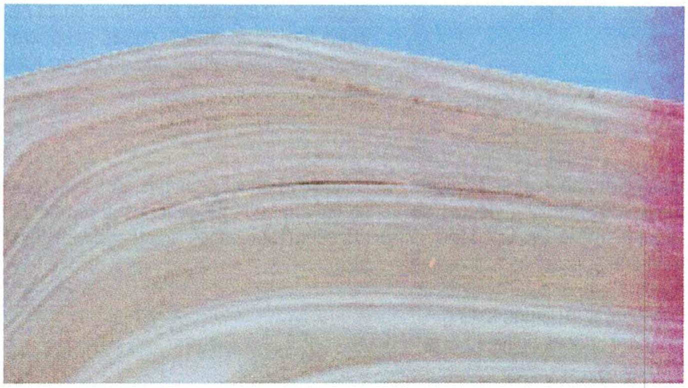


Fig. 1.4.3: Color streaks in transmitted light; magnification 7:1

2. Peeling/Delamination

Appearance	Cause	Correction
Detached, slate-like surface layers, e.g. due to cross cutting; usually not easy to identify since the surface is flawless; a "skin" can often be pulled off when the surface is scratched with a blade. The molded part exhibits bubbling after warm storage.	1. High shear stresses result in the formation of layers; even in compatible multiphase systems. 2. Contamination with an incompatible thermoplastic or master batch.	1. Increase the melt temperature and reduce the injection speed. 2. Avoid contamination due to extraneous material or due to an unsuitable master batch (specifically the carrier).

3. Weld line

Appearance	Cause	Correction
Notches, hairlines	Appear in multiphase systems such as ABS or ASA. Flow fronts having an already cooled peripheral layer encounter one another and no longer allow fusion without marks.	As far as possible, position weld lines where they have no visual or mechanical impact (flow promoters, flow inhibitors); check mold engineering: if necessary enlarge sprue channel, gate and machine nozzle; avoidance of aprupt changes in wall thickness and nonuniform mold filling; provide effective mold venting.
Change in apparent color; especially when inorganic decorative effect pigments are used the weld line appears as a dark line; conspicuous in dark, brilliant or transparent moldings having smooth surfaces polished to a high gloss.	Decorative effect pigments and, e.g., glass fibers tend to straighten up in the region of the weld line (adversely affecting appearance and usually mechanical properties also).	Processing: Optimization of melt temperature, mold surface temperature and injection speed; new color formulation (organic or inorganic pigments, higher pigmentation). Use lower viscosity material.

2. Peeling/Delamination

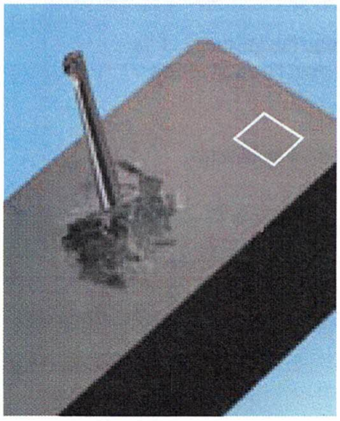


Fig. 2.1: Peeling and delamination caused by strange material in the granules

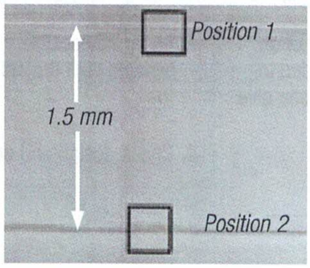


Fig. 2.2: Partial cross section through Fig. 2.1: (sample thickness 1.5 mm)

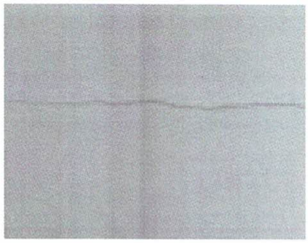


Fig. 2.3: Position 1

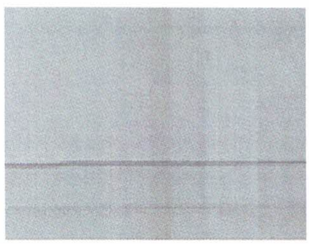


Fig. 2.4: Position 2

3. Weld line

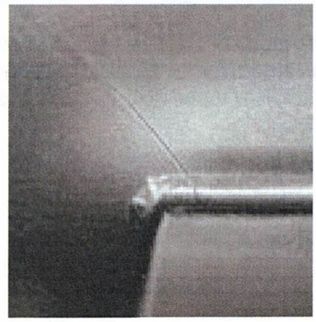


Fig. 3.1: Weld line notches; vertical illumination, magnification 11:1

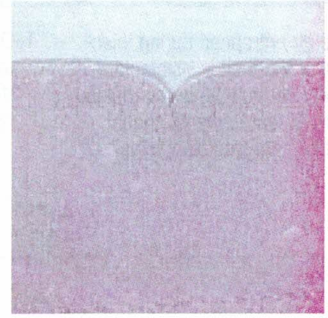


Fig. 3.2: Weld line notches; transmitted light, polished, magnification 560:1

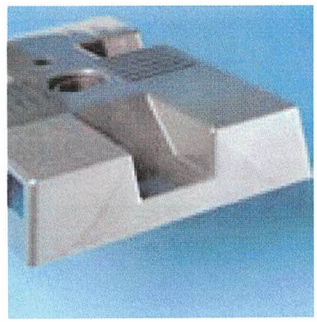


Fig. 3.3: Weld line (metallic effect coloring)

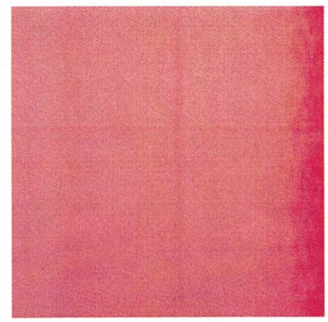


Fig. 3.4: Color marking in the weld line; vertical illumination, dark field, magnification 52:1

4. Air entrapments/bubble formation

Appearance	Cause	Correction
The air entrapped during injection of the melt is visible as a cavity (air bubble) in the molded part. Air entrapments should not be confused with voids.	1. During mold filling air is entrapped on account of an inopportune shape of the molding and if occluded in the peripheral region close to the surface this can give rise to bubbles.	1. As far as necessary optimize the geometry of the molding with the aid of a mold flow calculation. 2. Check design and condition of mold vents.

4. Air entrapments (bubble formation)
(front elevation and section)

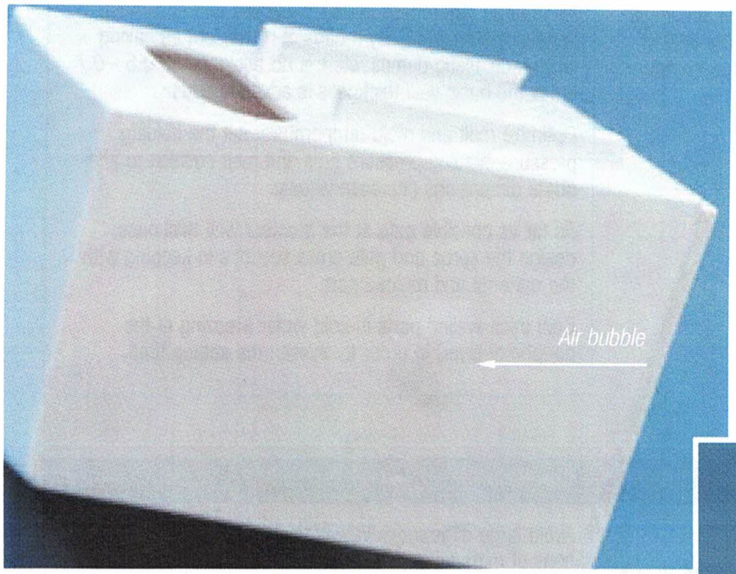


Fig. 4.1: Air entrapment

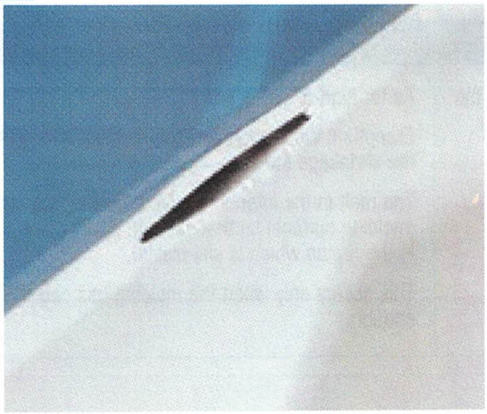


Fig. 4.2: Air bubble cut open

5. Sink marks

Appearance	Cause	Correction
Depressions on the surface of the molded part.	Sink marks are always produced in regions of accumulation of material when the contraction in volume arising during the cooling phase cannot be adequately compensated for by the holding pressure.	Avoid large differences in wall thickness and accumulations of material (e.g. by means of rib structures having large radii, fixing domes, etc.); a rib thickness of 0.5 - 0.7 times the basic wall thickness is advantageous. Optimize melt and mold temperature; set the holding pressure, holding pressure time and melt cushion to adequate dimensions (increase values). As far as possible gate at the greatest wall thickness; design the sprue and gate cross sections in keeping with the material and molded part. Cool thick-walled parts in cold water (freezing of the peripheral layer) in order to shorten the setting time.

6. Voids

Appearance	Cause	Correction
Usually not discernible from the outside except in the case of transparent materials. Parts, usually thick-walled, which have been cut open reveal cavities.	As for Item 5. Exception: When the outer skin is thick enough to absorb the shrinkage stresses. The melt in the interior is pulled towards the outside (molding surface) so that vacuum cavities are produced in the region which is still plastic. This occurs only when the molding has cooled for long enough.	Avoid large differences in wall thickness and accumulations of material (e.g. by means of rib structures having large radii, fixing domes, etc.). Pay heed to correct temperature control; set the holding pressure, holding pressure time and melt cushion to adequate dimensions. As far as possible gate in the thickwalled area; design the sprue and gate cross sections in keeping with the material and molded part.

5. Sink marks

(front elevation and section)

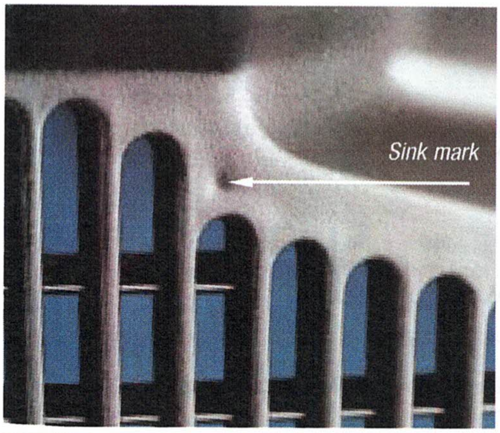


Fig. 5.1: Sink mark on the visible side (Cause: Material accumulation as shown in Fig. 5.2)

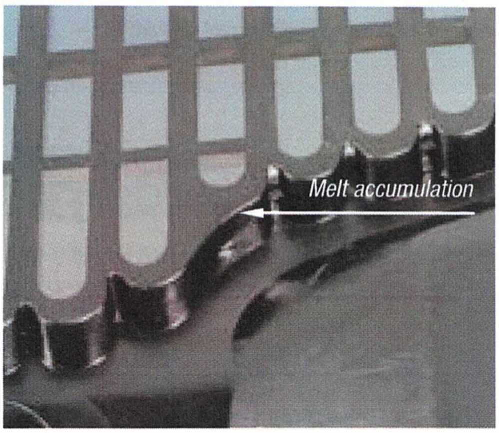


Fig. 5.2: Material accumulation (avoidable by suitable recessing)

6. Voids

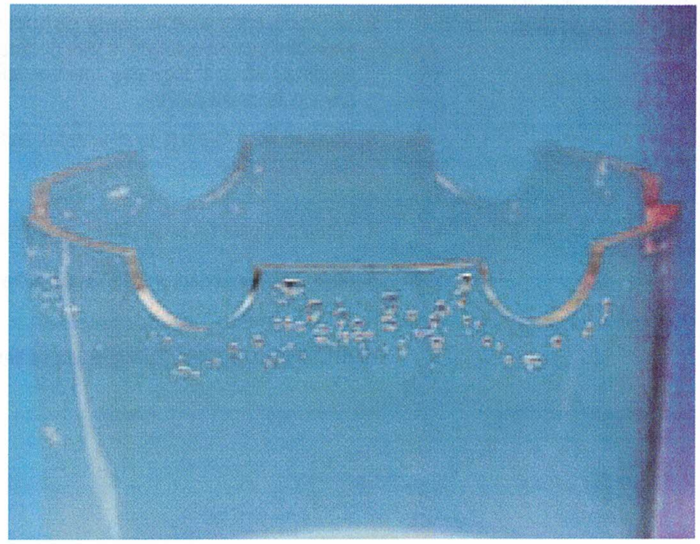


Fig. 6.1: Voids at the end of the flow path in a cup

7. Glossy spots or differences in gloss/mat spots

Appearance	Cause	Correction
Injected parts generally having a gloss which is too low or too high. Nonuniform apparent gloss or color at certain areas.	1. As a result of design related material accumulations, such as aprupt changes in wall thickness, ribs and fixing bosses sink marks are produced which give rise to glossy spots in textured surfaces.	1. Avoid material accumulations and aprupt changes in wall thickness; gate the part in the thickwalled area.
	2. Mat spots often arise on glossy parts having complex geometry (aprupt changes in wall thickness, ribs, openings) when at the same time the mold filling process is unsatisfactory.	2. Optimize the part and mold filling, e.g. injection profile (multistage injection). Polish the finished part.
	3. On weld lines due e.g. to alignments and changed flow conditions.	3. As far as possible position weld lines where they are not visible (flow promoters, flow inhibitors); mold flow studies also provide guidance.
	4. Sprue and gate cross sections are too small.	4. Have adequately sized sprue and gate cross sections.
	5. Mold wall temperature, melt temperature and injection speed are not favorable.	5. Optimize the processing temperature. Check the mold cooling and coolant flow.
	6. Holding pressure and holding pressure time are too low.	6. Adjust holding pressure and holding pressure time.

7. Glossy spots or differences in gloss/mat spots
(Automobile mirror mounting)

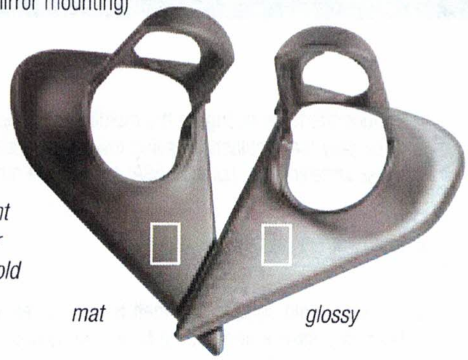


Fig. 7.1: Differences in gloss on account of good (mat) or poor (glossy) mold reproduction

Fig. 7.2: High reproduction accuracy (mat); scanning electron micrograph, magnification 50:1

Fig. 7.4: Poor reproduction accuracy (glossy); scanning electron micrograph, magnification 50:1

Fig. 7.3: High reproduction accuracy (mat); scanning electron micrograph, magnification 200:1

Fig. 7.5: Poor reproduction accuracy (glossy); scanning electron micrograph, magnification 200:1

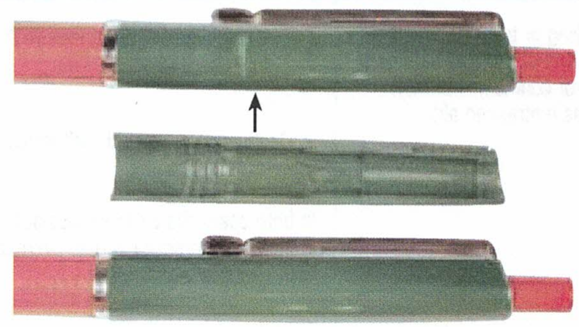
8. Microcracks, crazing and stress whitening

Appearance	Cause	Correction
Milky to whitish cloudiness (incident light is scattered diffusely).	Due to exceeding the maximum permissible yield point as a result of the following for example.	
	1. Action of external force, arising for example from forcible demolding of undercuts.	1. Reduce the force acting on the molding from the outside or employ thermoplastics having lower susceptibility to stress whitening e.g. Luran S (ASA) optimize the molddesign.
	2. Overstressing the component.	2. Improvement of the part design.
	3. Internal stresses in the part due to inappropriate processing conditions.	3. Increase mold surface and melt temperatures, reduce holding pressure and setting times and adjust injection speed; aim for low-stress processing in line with the requirements of the material; do not demold under residual pressure; select the ejector mechanisms and demolding drafts in such a way that troublefree demolding without relatively great force is ensured; alteration of sprue and gate conditions; modification of part design.
	4. Use of mold release sprays which may, for example, cause stress cracking.	4. Employ suitable demolding aids.

8. Microcracks, crazing and stress whitening

Fig. 8.1: Microcracks produced by overloading and deforming under residual pressure

a)



b)

Fig. 8.2:

a) Ballpoint pen with stress whitening in the thread region (undercut) made from pure polybutadiene ABS

b) The same ballpoint pen without stress whitening made from Luran®S (ASA)

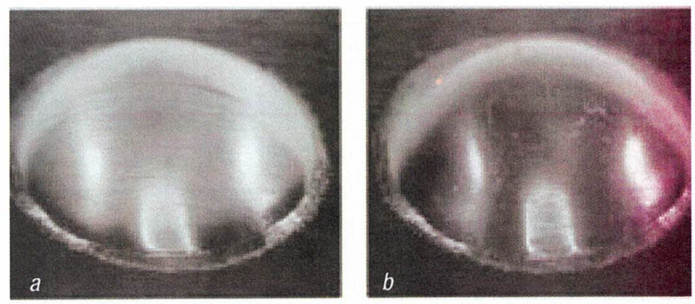


Fig. 8.3: Terluran® (967 K) Luran® S (ASA)

9. Diesel effect

Appearance	Cause	Correction
Scorching or black colorations at the end of the flow path or at points of confluence of melt streams (entrapped air).	1. Poor venting of mold at flow path ends or 2. Confluence of several melt fronts. In both cases the air to be displaced from the mold cavity is highly compressed and so overheated that the plastic melt chars locally.	1. Provide effective venting in the critical regions; reduce injection speed and melt temperature. 2. Identify critical points at the planning stage using a moldflow simulation for example and correct the shape, gate location and wall thickness-distribution of the part by modifications. 3. Decrease clamp force to provide a temporary solution.

9. Diesel effect

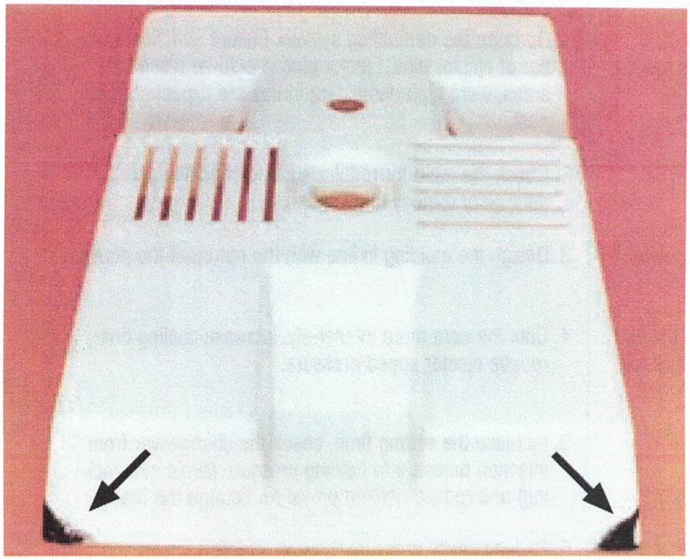


Fig. 9.1: Scorch marks due to poor mold venting at the end of the flow path

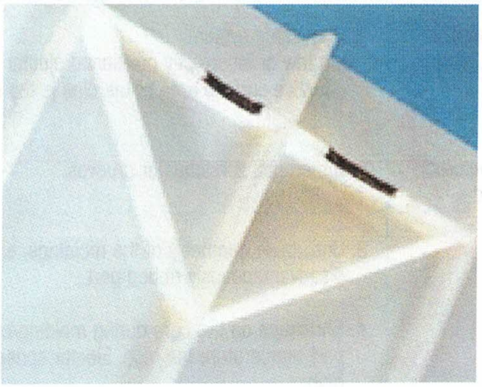


Fig. 9.2: Local charring on ribs due to lack of mold venting

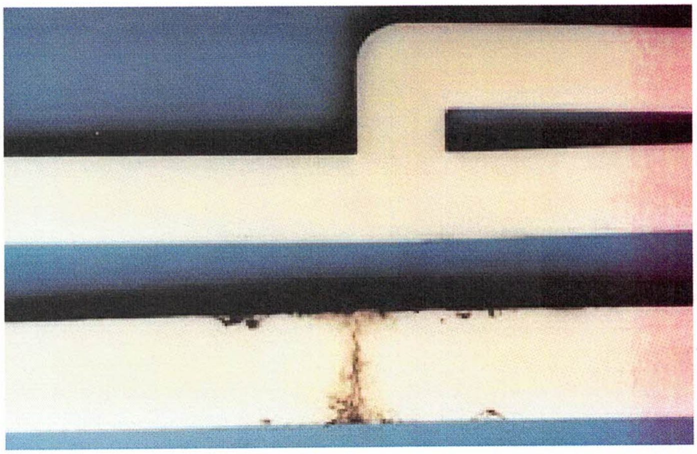


Fig. 9.3: Black discoloration at the confluence of two melt fronts

10. Demolding problems

Appearance	Cause	Correction
1. The surface exhibits ejector marks (differences in gloss, stress whitening and deformation).	1. Demolding system: too few or incorrectly positioned ejector pins or the effective surface area of the pins is too small.	1. Optimize the demolding system. Ensure sufficient number of ejector pins. Ejector pins should be placed in areas, were high demolding forces are expected (e.g. ribs).
2. Part is damaged (punctured), fractured or squashed.	2. Undercuts, scratches or grooves.	2. Check the mold for regular surface condition and if necessary remedy any defects.
	3. Unsuitable geometry of the moldings, e.g. a highly or disadvantageously ribbed part.	3. Design the molding in line with the nature of the plastic.
	4. Shrinkage on the core during molding/cooling. Ejected part temperature too high. Ejector speed/pressure too high.	4. Cool the core more intensively. Increase cooling time, reduce ejector speed/pressure.
	5. Overpacking the mold.	5. Increase the setting time, check the changeover from injection pressure to holding pressure (avoid overpacking) and reduce holding pressure. Enlarge the drafts.
	6. Inadequate drafts. Draft not matched to the surface structure.	6. Reduce cavity pressure through injection speed and melt temperature.

10. Deformation on demolding

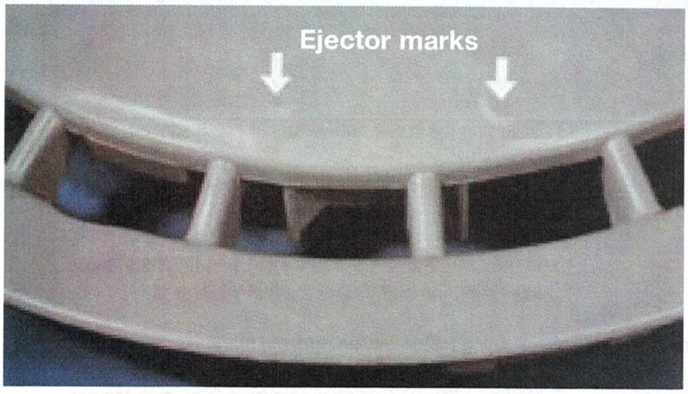


Fig. 10.1: Ejector marks due to the effective surface area of the ejector pins being too small

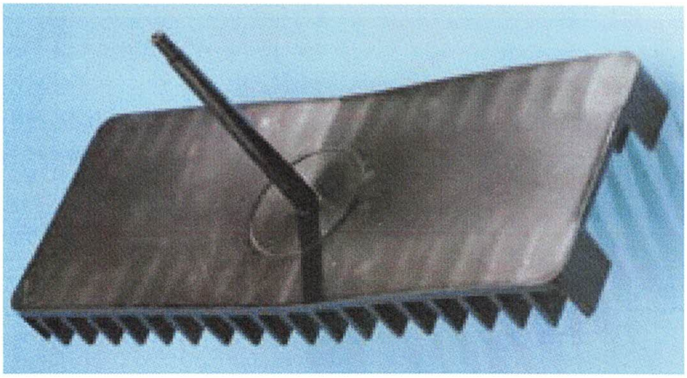


Fig. 10.2: Deformed part as a result of overpacking and shrinkage onto the core of the mold

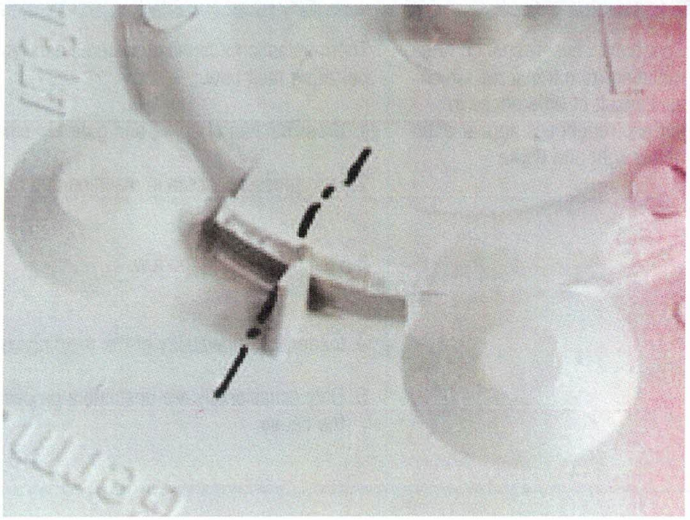
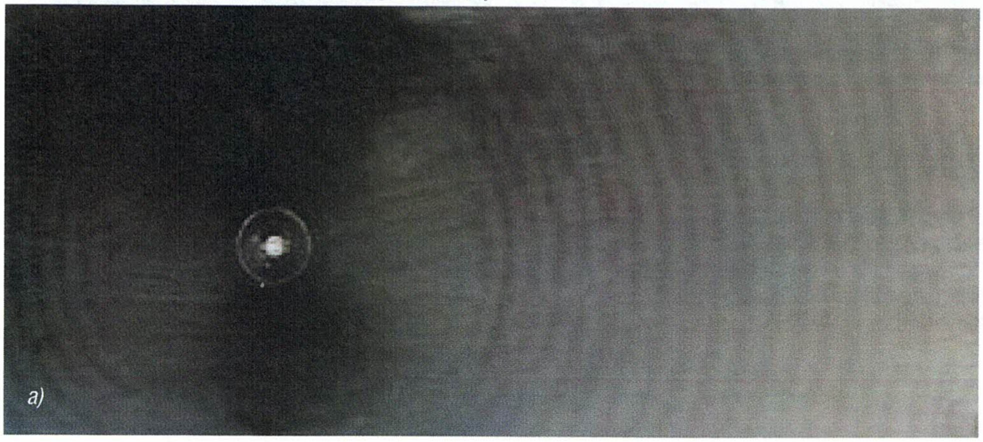


Fig. 10.3: Demolding fracture; an excessively large undercut causes the bracket to be torn off

11. Push marks ("tiger stripes/tiger lines")

Appearance	Cause	Correction
Concentric, evenly spaced rings radiating from the sprue which as a result of differences in surface roughness appear alternately light and dark.	Thermoplastic multiphase systems can tend towards pulsating melt flow.	
	1. Cross section of sprue and gate too small.	1. Enlarging the sprue and/or runner cross section.
	2. High pressure losses in machine and hot runner nozzle.	2. Reduce pressure losses in the machine and hot runner nozzle.
	3. Wall thicknesses too low.	3. In the case of thin-walled molding with large surfaces increasing the wall thickness often yields success.
	4. Inadequate flowability of the molding compound.	4. Employ a better flowing material grade.
	5. Only occasionally are unsuitable processing conditions the cause.	5. Optimize the processing parameters (high melt temperature, high mold surface temperature, medium to low injection speed and high holding pressure).

11. Push marks ("tiger stripes/tiger lines")



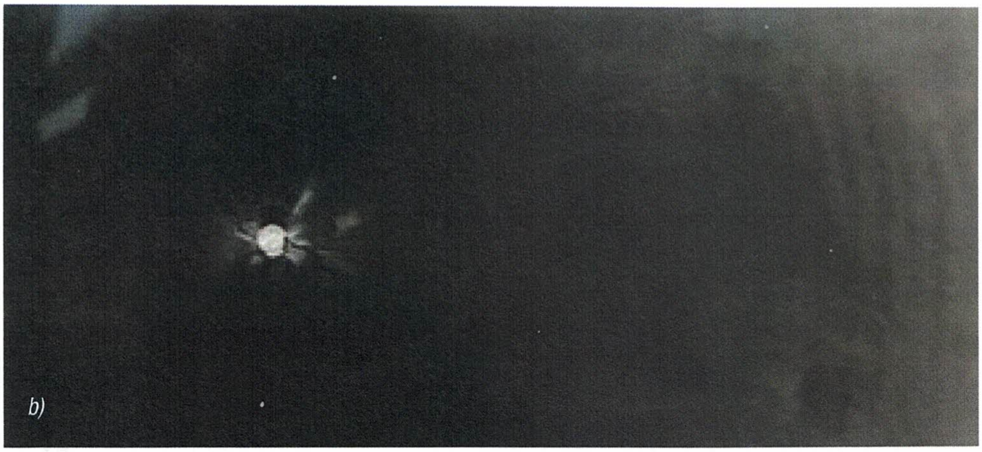


Fig. 11.1:
a) Tiger stripes as a result of the sprue cross section being too small
b) Remedied by enlarging the sprue cross section

12. Record effect

Appearance	Cause	Correction
Grooved surface which propagates along the course of the melt front. The appearance of this surface defect is similar to the grooves in a record. Predominantly at the end of the flow path.	Melt and mold surface temperatures and injection speed too low and flow cross section too small. Explanation: Rapid cooling of the flow front regions close to the wall (frozen peripheral layer) causes the flow resistance in the molding cavity to rise and the otherwise uniform, laminar spread of the plastic melt to the wall to stagnate intermittently. The plastic melt does not make full contact with the mold wall.	Increase the melt temperature, mold surface temperature and screw advance speed. Enlarge the flow cross sections and optimize the shape of the molding. Reduction of the flow path lengths by means of additional sprue gates.

12. Record effect

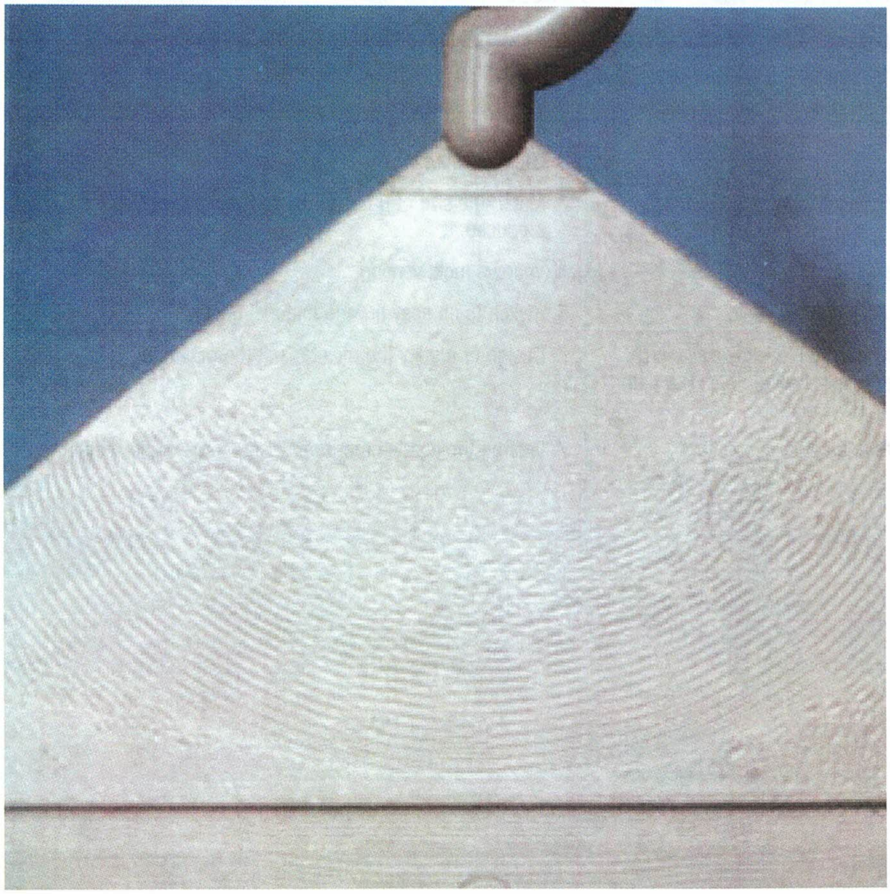


Fig. 12.1: Record effect as a result of the melt temperature and injection speed being too low

13. Short shot

Appearance	Cause	Correction
Molding is incompletely filled by injection.	1. Melt temperature, mold surface temperature and injection speed are too low.	1. Increase the melt and mold surface temperatures together with the injection speed.
	2. Shot volume is too low, not enough material plasticised, no melt cushion.	2. Increase the shot volume and check the nonreturn valve. (Shot volume too low; no melt cushion). Increase the back pressure.
	3. The injection pressure is insufficient. Machine is too small.	3. Match the size of the machine to the molding to be produced.
	4. Inadequate mold venting.	4. Improve mold venting.
	5. Inadequate flowability of the plastic melt.	5. Switch to an easy flowing material grade.
	6. The mold was designed with wall thicknesses which are too small or with long, thin-walled ribs. Flow path too long.	6. Design or modify the mold to suit the material.
	7. Unfavorable nozzle bore and sprue geometry.	7. Enlarge the nozzle bore, runner and sprue cross section.

13. Short shot

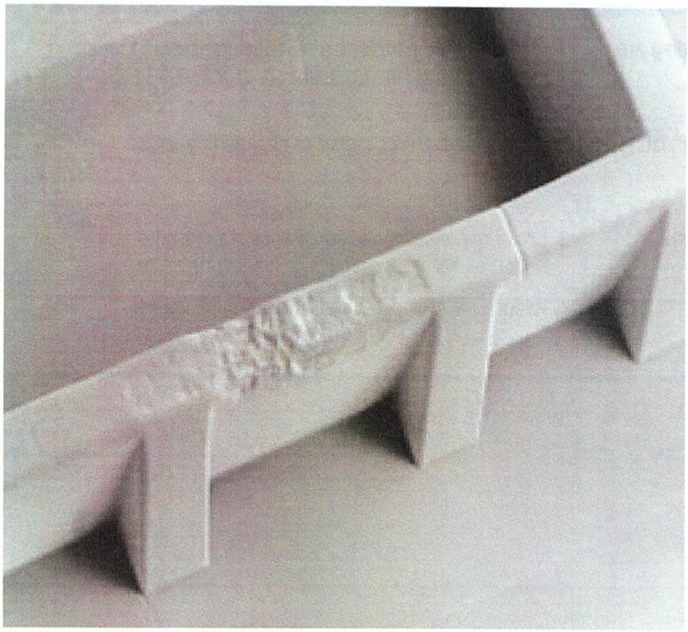
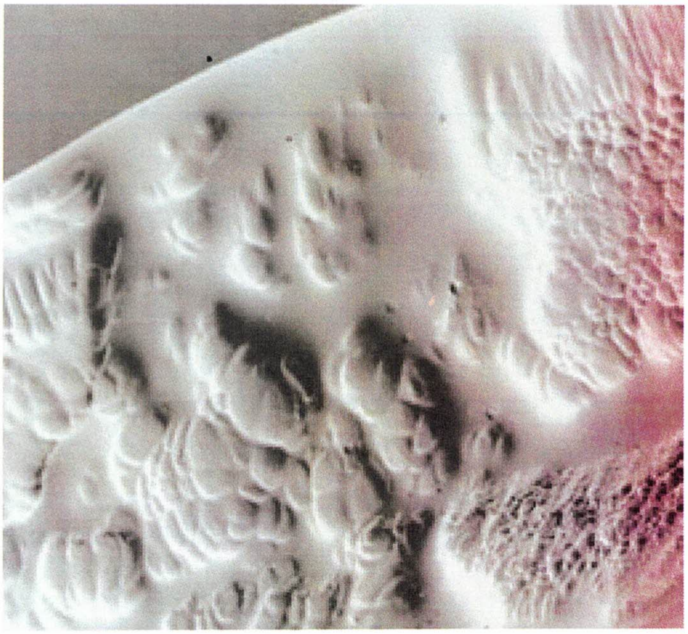


Fig. 13.1: Crosspiece incompletely formed; scanning electron micrograph, magnification 7:1

Fig. 13.2: Detail from Fig. 13.1; scanning electron micrograph, magnification 50:1



14. Flash formation

Appearance	Cause	Correction
Moldings exhibit flash formation, e.g. at the mold parting surface.	1. Fitting tolerances of the two halves of the molding are too great or the mold parting line is damaged. 2. Clamp force of the machine is inadequate (high lifting forces) or is set too low. 3. Melt temperature, injection speed or internal mold pressure is too high.	1. Adjust mold to permissible fitting tolerances and repair existing damage in the mold parting line. 2. Set the clamp force higher or change to a larger machine. 3. Lower the injection speed and holding pressure or switch earlier from injection to holding pressure. 4. Reduce melt temperature and mold temperature.

14. Flash formation

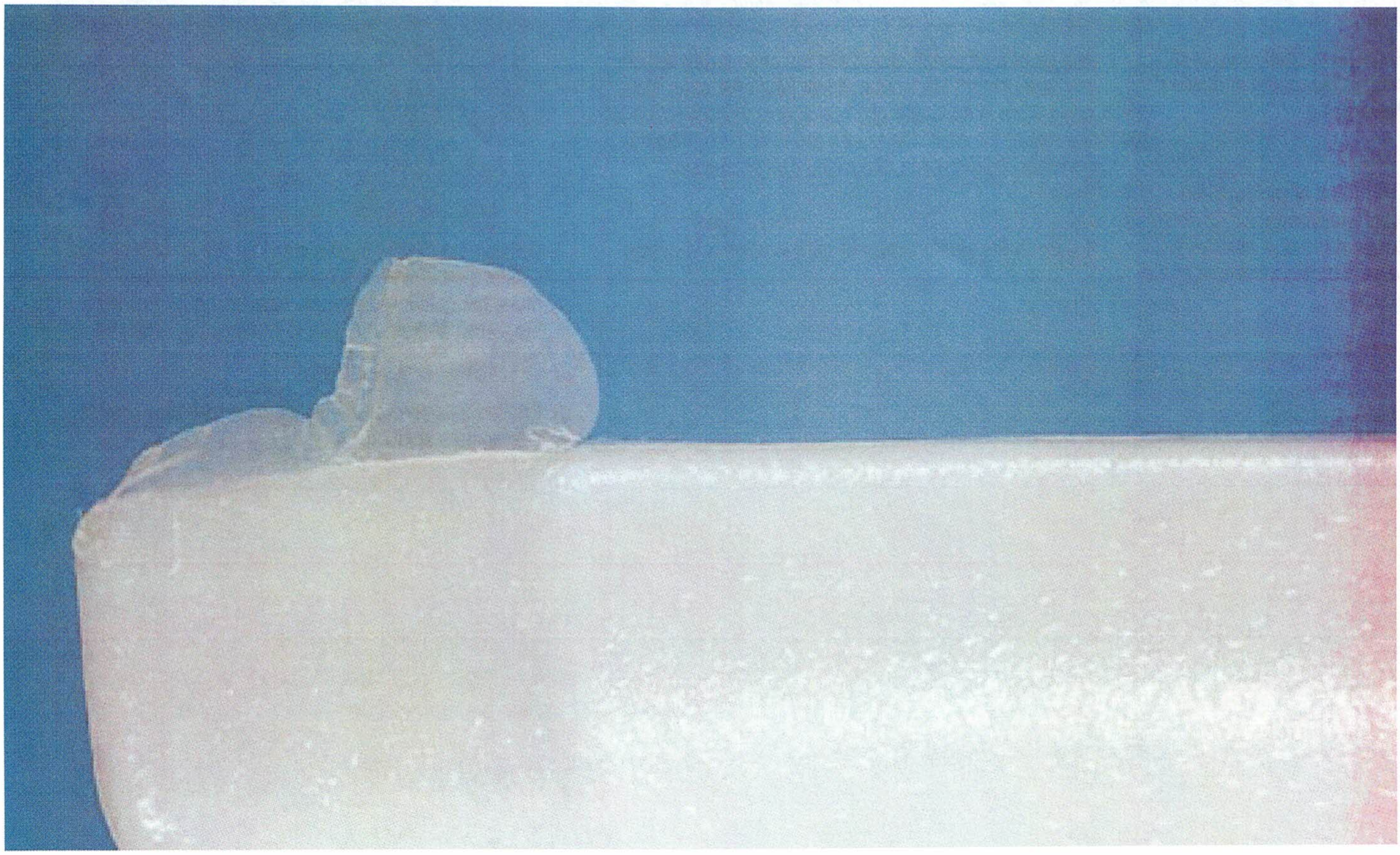


Fig. 14.1: Flash formation as a result of the clamp force of the machine being set too low

15. Jetting

Appearance	Cause	Correction
Generally a snake-like jet of melt visible on the surface of the molding.	The jet of melt shoots directly in the open cavity without any wall contact (no laminar flow). Since the outer skin cools there is no longer any homogeneous connection to the rest of the melt; the results are weld lines, inhomogeneities, cold forming and local internal stresses.	
The strand of melt is often rough, mat and exhibits differences in gloss or color with respect to the remainder of the molding.	1. Due to the wrong choice of gate location and design.	1. Position the gate in such a way that the jet of melt strikes a mold wall or a baffle plate (laminar flow). Make the gate large enough. Attachment of radii in the transition from the gate to the molding is helpful. 2. Use higher viscosity material. 3. Profiled injection velocity (slow to normal) may provide a temporary solution.

15. Jetting

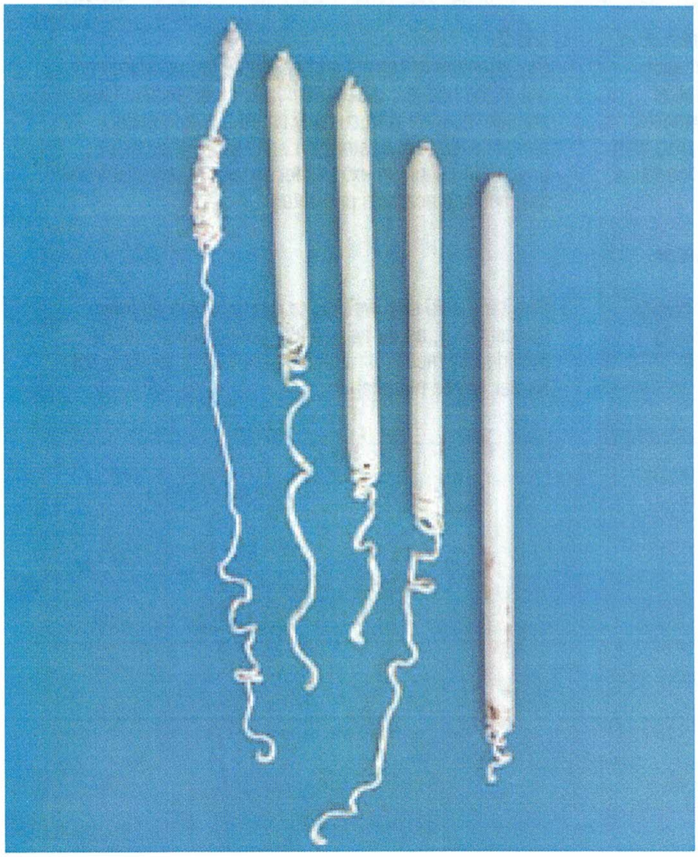


Fig. 15.1: Formation of jets of material with reference to the example of a peg

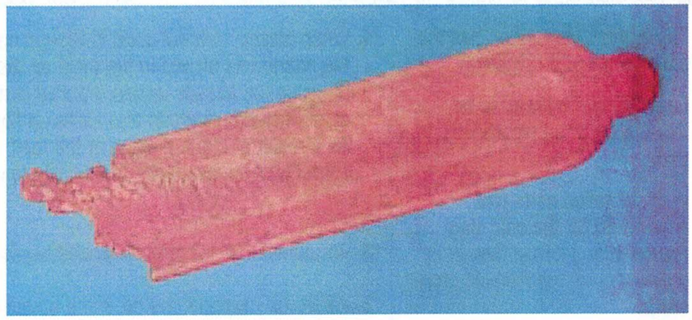


Fig. 15.2: Jetting due to unsuitable choice of gate location and design

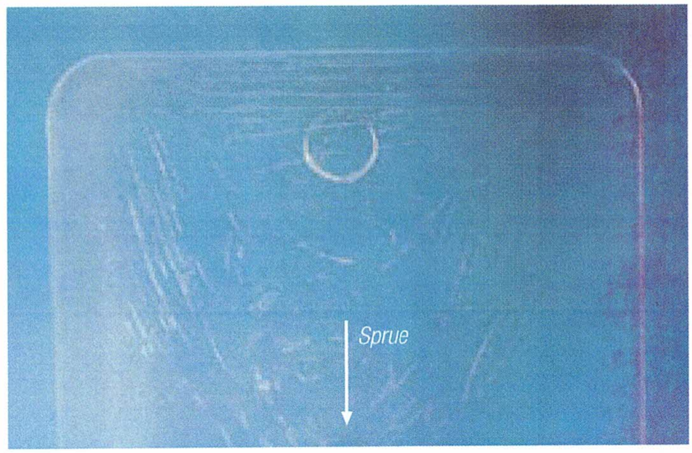


Fig. 15.3: Jetting on a flat transparent part

16. Cold slug

Appearance	Cause	Correction
The surface mark often has the appearance of a comet tail. Easily visible in the case of thin-walled or transparent parts. In thick-walled parts (not always visible) the cold slug results in an internal flaw or in a reduction of mechanical properties.	1. When plastic material cools in the gating system or in the nozzle and arrives in the mold on the next shot. Because the already cooled material is not melted again the cold slug can also close up flow channels. As a result of this a division of the melt may arise with consequent surface faults comparable to weld line faults. 2. An unheated or incorrectly heated machine nozzle.	1. and 2. Pay attention to correct and adequate temperature control of the nozzles; make the nozzle cross section large enough; operate with suitably timed and adequately dimensioned screw retraction and reduce the back pressure to such an extent that escape of material from the machine nozzle is prevented.
	3. When, for example, the tip of the tunnel gate breaks off and lands with the next shot in the mold cavity (only arises with brittle materials such as SAN).	3. Provide a cold slug well in the runner which receives the cold slug; as far as possible gating should not be provided by means of a tunnel gate but rather via a hot runner (brittle materials).

16. Cold slug

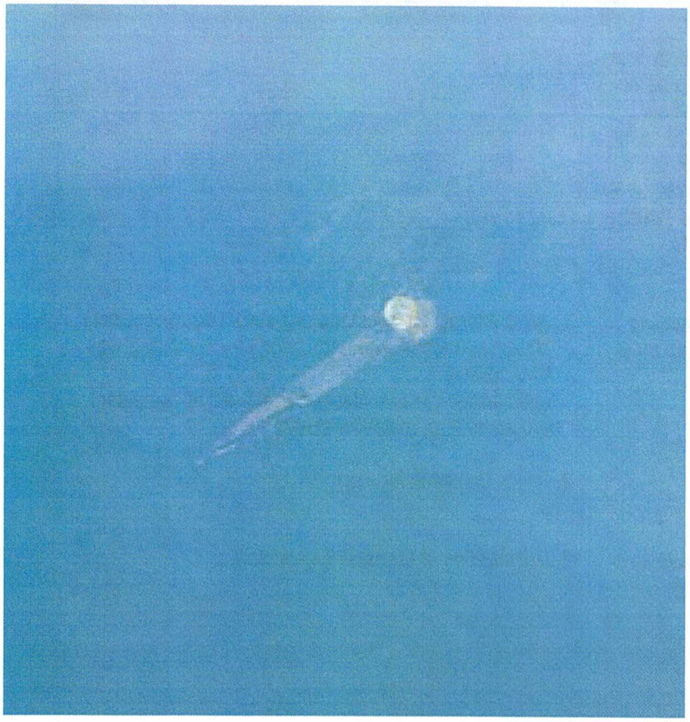


Fig. 16.1: Cold slug with comet tail

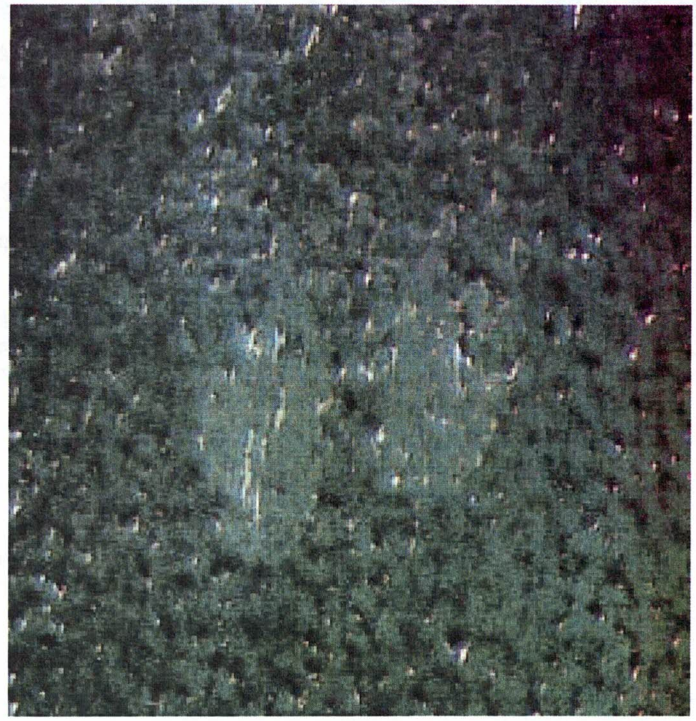


Fig. 16.2: Cold slug in vertical illumination, enlarged

17. Warpage

Appearance	Cause	Correction
Molding exhibits deformations and twists (deviation from desired shape).	Due to their low shrinkage of 0.3-0.7 % substantially less marked in styrene copolymers than in partially crystalline materials (shrinkage 1-3 %); in the case of glass-fiber reinforced SAN, ABS and ASA shrinkage is reduced so far that the lengthwise / crosswise differential is approx. 0.1 %. As a result this effect is practically nonexistent. Terblend® N is an exception. Due to its PA6 content it tends to exhibit higher shrinkage and is a little more susceptible to warpage.	
	1. Unsuitable molding design and distinct differences in wall thickness resulting in different internal mold pressures and in different shrinkage behavior.	1. Avoid internal stresses and alignments by the correct choice of material and parts geometry (balancing wall thicknesses); optimization of the molding with the aid of computer programs (e.g. moldflow study).
	2. Incorrect position and design of sprue.	2. Check the sprue location.
	3. Due to incorrect setting of mold temperature and injection speed as well as unsuitable design of mold temperature control.	3. Optimization of processing conditions.

17. Warpage

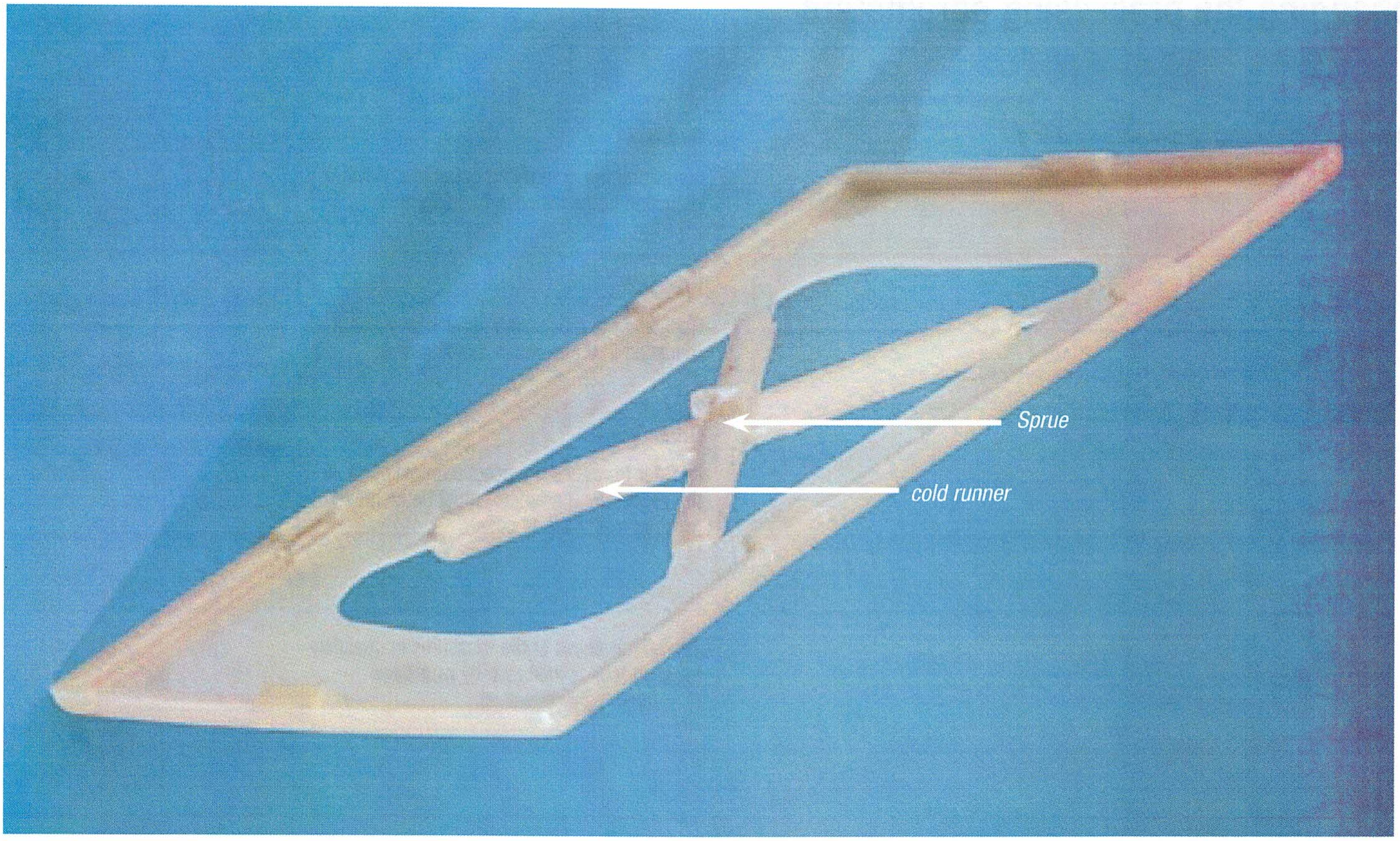


Fig. 17.1: Distorted frame resulting from unfavorable part geometry (thick walled edge in this case) when the sprue position is incorrect thinwall area

II. Overview: Control of injection molding faults by changing the processing parameters

Overview of the avoidance of injection molding faults by changing the processing parameters

Red box

Increasing the processing parameter yields a reduction in the injection molding fault.

Blue box

Reducing the processing parameter yields a reduction in the injection molding fault.

Green box

In order to reduce the injection molding fault the processing parameter must be increased or reduced from case to case.

The effectiveness of the measures in question for each fault is indicated by **numbers** (1 = most highly effective).

= Increase (red)
= Decrease (blue)
= Change (green)

Problems / Solutions	Melt temperature	Mold temperature	Mold cooling time	Injection speed	change over point (injection to hold)	Hold pressure	Hold time	Back pressure	Screw rpm	Shot size	Screw decompression	Clamp force	Material moisture	Material contamination	Mold design	Part design	Gate cross section
Splay marks								2 (Increase)					1 (Decrease)				
Silver streaks	3 (Decrease)			1 (Decrease)				5 (Decrease)	4 (Decrease)								2 (Increase)
Color streaking	3 (Increase)			4 (Increase)				1 (Increase)	2 (Increase)					6 (Change)	5 (Change)		
Delamination	2 (Increase)			3 (Decrease)										1 (Increase)			
Weld Line Appearance	1 (Increase)	2 (Increase)		3 (Increase)		(Increase)									4 (Change)	5 (Change)	
Bubbles in part															1 (Change)	2 (Change)	
Sink Marks	1 (Decrease)				(Change)	2 (Increase)	3 (Increase)			4 (Increase)					7 (Change)	6 (Change)	5 (Increase)
Voids	5 (Decrease)	4 (Increase)			(Change)	1 (Increase)	2 (Increase)			3 (Increase)					8 (Change)	7 (Change)	6 (Increase)
Mat spots/glossy spots		1 (Change)	2 (Change)	3 (Change)	(Change)	4 (Change)	5 (Change)								8 (Change)	7 (Change)	6 (Increase)
Crazing/stress whitening	2 (Increase)	1 (Increase)		5 (Change)	(Change)	3 (Decrease)	4 (Decrease)								7 (Change)	6 (Change)	
Diesel effect	2 (Decrease)			1 (Decrease)								3 (Decrease)			4 (Change)		
Sticking in Cavity		2 (Decrease)		3 (Decrease)	(Change)	4 (Decrease)									1 (Change)		
Push marks	4 (Increase)	3 (Increase)		6 (Change)		5 (Increase)									2 (Change)		1 (Increase)
Record effect	1 (Increase)	4 (Increase)		2 (Increase)													3 (Increase)
Short Shot	3 (Increase)	4 (Increase)		2 (Increase)	(Change)					1 (Increase)					7 (Change)	6 (Change)	5 (Increase)
Flash	3 (Decrease)	4 (Decrease)		1 (Decrease)	(Change)	2 (Decrease)						5 (Increase)					
Jetting	3 (Decrease)			2 (Decrease)											1 (Change)		
Cold Slugs								2 (Decrease)			1 (Decrease)				3 (Change)		
Warpage		3 (Change)	4 (Increase)	6 (Increase)		5 (Change)									2 (Change)	1 (Change)	

Do you have technical questions about BASF's styrene copolymers?

We will be happy to advise you at our Styrenics Infopoint:

Internet: www.basf.de

If you have additions or suggestions for this brochure please contact:

Tel.: +49(0)621/60-42962
E-Mail: egon.erter@basf-ag.de

Luran®	SAN
Terluran®	ABS
Luran® S	ASA (ASA + PC)
Terlux®	MABS
Terblend® N	ABS + PA

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BASF Aktiengesellschaft
67056 Ludwigshafen
Germany