Content

Designing injection molds

To avoid tool-related extraneous deposition on LDS-MID components during the metal coating stage, injection molds should not be made of aluminium. The molds have to be designed to ensure that mold tempering is neutral in time and space. Component shrinkage during the production process should be taken into consideration in advance. This can be minimised through the appropriate selection of the injection molding parameters. A MoldFlow simulation is a good way of analyzing this problem before producing molds for mass production.

Picture 1: Injection molded plastic part

The required edge radius should already be taken into consideration in planning during the mold construction phase. Radii which are too tight can have a negative impact on the gaps and tracks. Sharp-edged transitions around the metallized structures should be avoided where possible to prevent damage. The mold should be designed so that there are no injection points and ejectors near the tracks undergoing subsequent metal coating. This is because these points are liable to cause faulty structuring and metal coating. Hot runner systems should be used where possible to prevent unwanted extraneous metal coating on the break-off and shear edges caused by mechanical activation of the polymer.

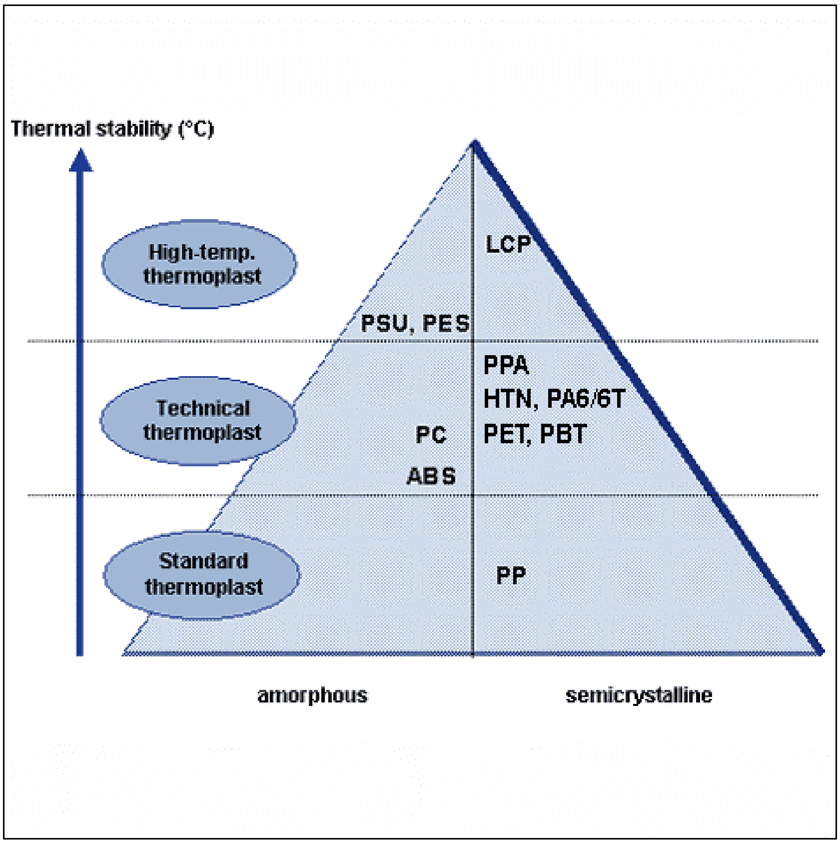
Weld lines are particularly important factors in injection-molded MID components: they are critical points. The artwork should not go over the weld lines because mechanical stress or temperature fluctuations can generate tension cracks and break the tracks. The position of the weld lines should be determined in advance by injection tests or fill analysis.

Injection molding

LPKF Laser & Electronics AG's design guidelines provide designers with reliable criteria for the design and production of MID components using the LPKF-LDS® method. Topic in this newsletter: injection molding.

Laser-structurable MID components are made using the single-component injection molding method. The technical specifications are similar to those for conventional injection molding. After selecting the optimal material, the dried and pre-heated polymer granulate is injected at high pressure into the mold. The solid, cooled component is removed from the mold and is then ready for structuring with the laser.

Users can select the best material from a range of tried-and-tested mass production materials available from different manufacturers (see: "Polymers: new PPA from RTP"). The precise processing instructions provided by the manufacturers have proven to be very good guidelines for handling the material. The April MID Newsletter already focused on the major importance of tool design in MID injection molding – in which special care is involved in particular in ensuring uniform tool tempering. Great care and attention must also be paid to the position of the bonding lines: the subsequent design of the layout must ensure that none of the tracks cross any of the bonding lines. The precise position of the bonding lines can be determined by filling tests.



Picture 2: Portfolio of polymer materials and suppliers for the LPKF-LDS method

Mold releasing agents, especially those based on silicone, should not be used with injection molded LDS-structurable components. The same applies to lubricants which – if it cannot be avoided – should only be used extremely sparingly. Any interruptions to the manufacturing process can have a negative effect on sustaining constant high quality. Injection molded MID components normally only require standard surface qualities – it is not necessary to polish the tools. Special care and attention is required when separating the components from the molds and the further handling of the MID: MIDs need to be treated as PCBs and not as rugged bulk articles.

Laser structuring

Laser structuring is a crucial part of the LPKF-LDS® method for the manufacture of innovative MID components. The aspects involved are summarised in the Design Guidelines issued by LPKF Laser & Electronics AG. Laser structuring is characterised by a small number of process steps and very fine structural resolution. Laser processing transfers the circuit artwork onto a three dimensional polymer component previously injection moulded using a laser-activatable thermoplastic (LDS compatible). To reduce the laser processing time, the planning phase should already ensure that the number of clamping positions is kept to a minimum, and make allowance for the maximum scan volume of each system.

Picture 3: Plastic part after laser activation

The angle of incidence of the laser beam onto the surface to be structured must comply with definite criteria: e.g. the recommended angle of incidence for reliable process activation should not be less than 65 degrees perpendicular to the surface to be activated. Transition zones and walls are critical positions which require special care during design and processing.

The laser power and the rate of feed have to be selected making allowance for keeping ablation to a minimum and reliably activating the metallic nuclei. Laser structuring can create tracks with widths less than 100 µm, but the actual dimensioning of the tracks and gaps depends on the specific application and should be defined in advance. Vias for subsequent plated-through holes also have to comply with certain criteria to ensure that the maximum angle of incidence of the laser beam is not exceeded. Detailed information can be found in the design guidelines for the laser structuring method which LPKF will make available for download at the end of this series of articles.

Metallization

After injection molding and laser structuring, metallization is the third main processing step in the production of MID components using the LPKF-LDS® method.

Before metallization, the semi-finished components are cleaned, followed by additive track formation. A chemical metal-deposition process in a current-free Cu bath selectively metallizes the defined circuit on the injection molded part. This selective metallization can only be carried out successfully by first doping the plastic component. The polymer is laced with metal compounds, and these are activated by the laser when it traces out the defined electronic circuit. The metallization baths usually build up layers of metal with thicknesses of 3 to 5 µm/h. For economic reasons, the maximum thickness built up using chemical copper-plating should not exceed 8 µm. If a thicker layer than this is specified for the planned application, this can be done either currentless or in an electroplating Cu bath. Other alternatives include application-specific coatings such as Ni, Au, Sn, Sn/Pb, Ag or Ag/Pd. NiP and Au can also be used as finish coatings.

Picture 4: Plastic part after metallization

Numerous metallization service companies are available if in-house metallization is not required. Several companies specialize in the metallization of LDS-activated MIDs.

Packaging and quality assurance

Our series on LDS design guidelines ends with packaging and quality assurance in MID production.

Picture 5: The results can be visually inspected for quality control

In principle, almost all of the standard packaging techniques can be used to assemble an injection-molded circuit carrier with surface mounted devices (SMD). Users can choose between lead-free soldering, gluing and wire bonding. The most suitable packaging method depends mainly on the component to be fixed and the area of application of the specific MDI subassembly. The area of application is also a key factor in the selection of the proper MID material – in particular, the thermal properties of a material are extremely important.

Three-dimensional assembly saves a great deal of room but is also a very challenging process to master. Although SMDs can be easily positioned at different levels, the parameters of the automatic assembly process need to be taken into consideration during the planning stage. The main aspects are to ensure that nothing hinders the free movement of the solder-paste dispenser and the component vacuum tweezers. Placing SMDs on slopes should also be avoided, and there should also be a gap between the SMD and the edge of the component.

Picture 6: Assembled MID part

Process-optimized systems, and regular control and maintenance, are vital to guarantee the permanent high quality of MID production processes. Optical inspection for instance can be used to control the results.

Your contact partner for the LPKF-LDS® process

Dr. Wolfgang John, the senior consultant at LPKF for the LPKF-LDS® method, will be happy to answer any questions you have on the design of mechatronic components. Dr. John is one of the leading experts in the MID field.

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