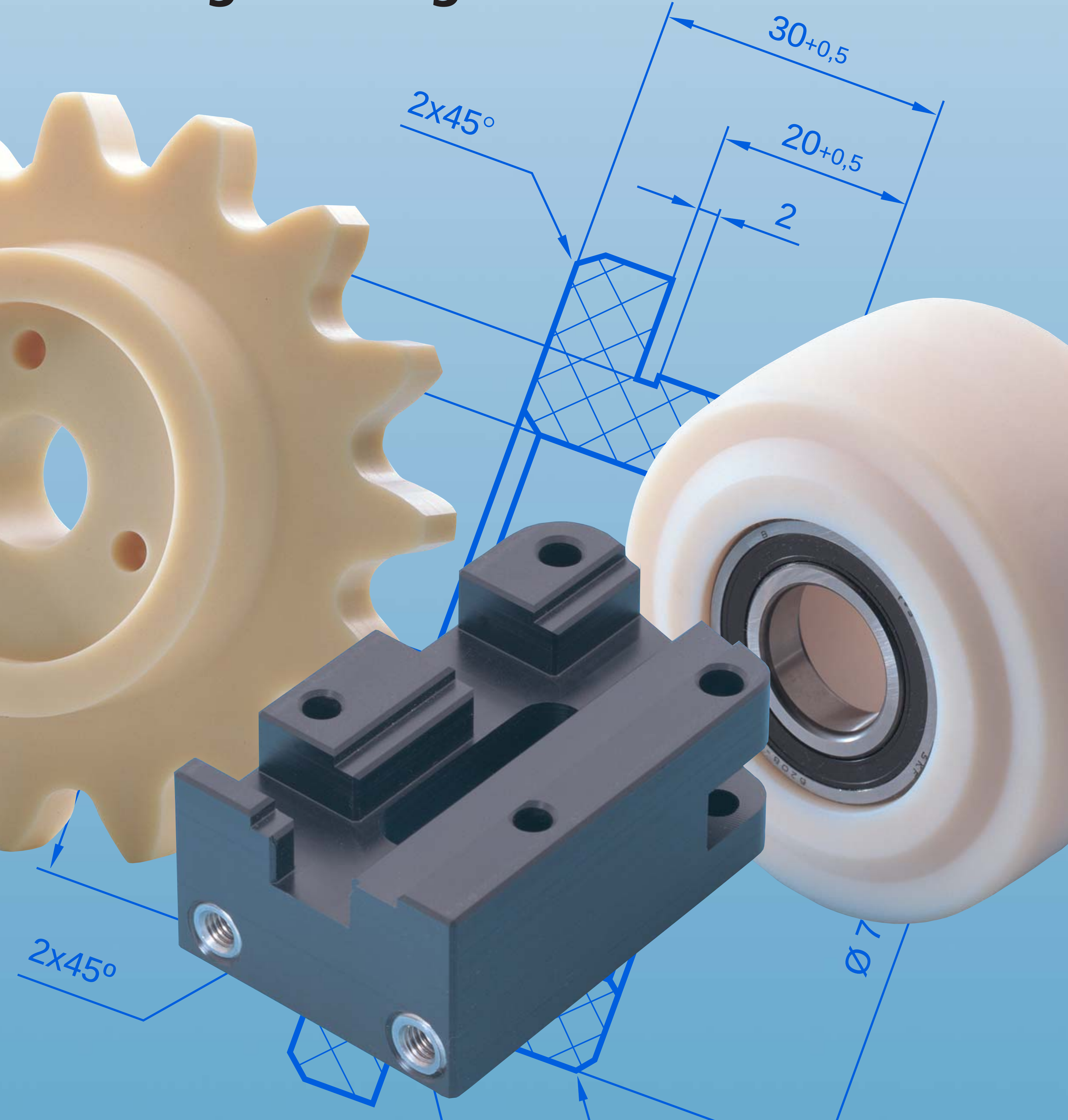
Licharz
engineering plastics

Designing with engineering Plastics



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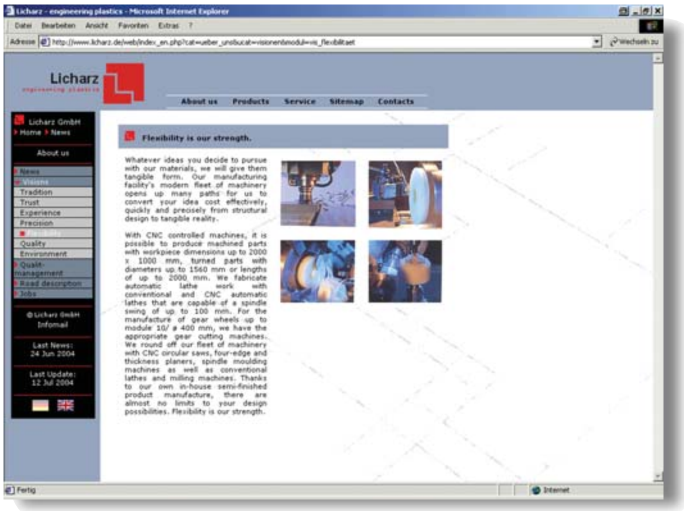

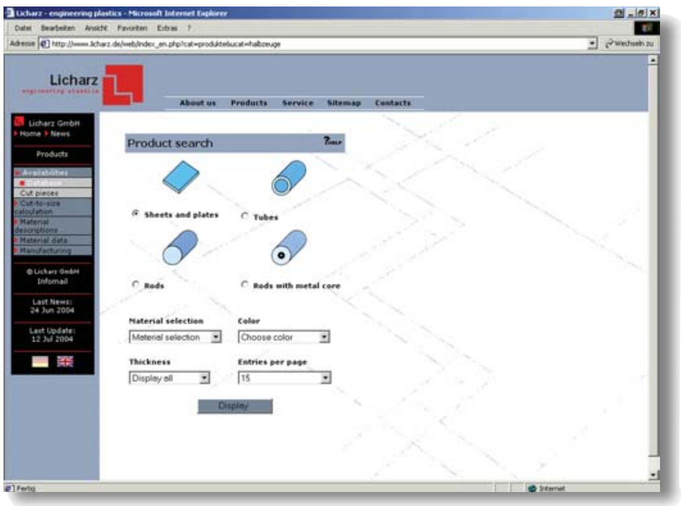

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Resistance to radiation and weathering

1. Plastics' resistance to radiation and weathering

Changes in plastics due to weathering effects and high-energy rays are often described as »aging«, with reference to the process of biological degradation. This is quite an accurate description since plastics, as organic materials, do not just have an analogy to natural substances in their constituents but also in their macromolecular structure.

The parallels are also obvious by the fact that we often speak of the "life" of a plastic product. The duration is determined by the decomposition of the plastic. It may be relatively long compared to other natural substances, but it is still limited.

1.1 Radiation

The majority of plastics are subject to decomposition or a cross-linking of the macromolecular structure when affected by high-energy radiation. The changes in the molecular structure that actually occur depend on the atmospheric oxygen.

When oxygen is present, generally oxidative decomposition of the plastic occurs. This is especially the case when the dose of radiation is small, the surface area of the product is large and the walls are thin. Under these prerequisites, the atmospheric oxygen has sufficient time to diffuse into the plastic and to occupy the valences that are made free by the radiation.

In the absence of oxygen, the plastic is partially decomposed by the main chains breaking up and partially cross-linked. Generally decomposition and cross-linking reactions happen at the same time, although one of the reactions is stronger.

In any case, the changes in the plastics caused by radiation are accompanied by a loss of mechanical properties such as mechanical stability, rigidity and hardness or brittleness. Plastics that are subject to cross-linking can experience a change in properties even leading to a rubber-elastic condition. Besides this, during both the cross-linking and decomposition of the plastics, small amounts of gaseous substances such as carbon monoxide or carbon dioxide are released.

Attention should be paid to the fact that the described changes are very gradual and that there is no sudden, unannounced change in properties. The effects of radiation on plastics depend on the geometry of the component, dosage, mechanical stress, temperature and the surrounding medium. Therefore, it is not possible to make a generalised statement about the damaging doses for individual plastics.

1.2 Weathering effects

Weathering resistance is mainly evaluated by the visual change of the surface. However, this leaves the question unanswered as to how the mechanical values change. On the one hand, it cannot be ruled out that plastics which are not subject to any great visual changes have a serious loss of mechanical properties and, on the other hand, plastics with considerable visual changes suffer no great loss of mechanical properties. But to evaluate weathering resistance correctly, the mechanical properties must be a measured. Some results of weathering are a decline in stability and hardness as well as an increase in elasticity or brittleness. The surface of the plastic can appear bleached or oxidatively decomposed or stress cracks can form.

The changes in plastics as a result of weathering are mainly caused by thermal and photo-oxidative reactions as well as by the intercalation of water molecules in the plastic's chain structure.

UV rays and warming by direct sunlight lead to chain decomposition and free valences that are saturated by oxygen diffusing inwards. The surface becomes yellow or bleached.

In the case of semi-crystalline plastics there could be secondary crystallisation resulting in increased hardness and rigidity. Consequently these plastics are also more brittle and lose a large part of their elasticity. Frozen residual stresses from the manufacturing process can relax and cause deformation through the effects of warming – similar to an annealing process. This is especially serious for thin-walled finished parts.

By absorbing water, the plastics become tough-elastic and stability and rigidity decline, which can also be a problem with thin-walled finished parts.

Weathering resistance can be improved with additives – in a similar way that fire retardant additives are used. However, it is not possible to provide a complete protection against decomposition caused by the effects of weathering.

Unfortunately no valid testing standard or standard parameters are defined regarding artificial weathering and its variables that could be used to compare resistances. However it can be said that plastics that have been coloured with carbon black or stabilised against UV rays with additives are more stable against light and weathering effects than light coloured or natural coloured grades. Exceptions to this are PVDF and PTFE, which have outstanding resistance to light and weathering effects even without colouring or additives.

When evaluating weathering resistance, it should also be remembered that changes caused by weathering effects are generally in the surface areas of the product. Deeper layers are usually not attacked, so that thick-walled parts are less affected by change than thin-walled parts.

Our machining capabilities:

- CNC milling machines, workpiece capacity up to max. 2000 x 1000mm
- 5-axis CNC milling machines
- CNC lathes, chucking capacity up to max. 1560 mm diameter and 2000 mm long
- Screw machine lathes up to 100mm diameter spindle swing
- CNC automatic lathes up to 100mm diameter spindle swing
- Gear cutting machines for gears starting at Module 0,5
- Profile milling (shaping and molding)
- Circular saws up to 170mm cutting thickness and 3100mm cutting length
- Four-sided planers up to 125mm thickness and 225mm width
- Thickness planers up to 230mm thickness and 1000mm width

We process:

• Polyamide	PA
• Polyacetal	POM
• Polyethylene terephthalate	PET
• Polyethylene 1000	PE-UHMW
• Polyethylene 500	PE-HMW
• Polyethylene 300	PE-HD
• Polypropylene	PP-H
• Polyvinyl chloride (hard)	PVC-U
• Polyvinylidene fluoride	PVDF
• Polytetrafluoroethylene	PTFE
• Polyetheretherketone	PEEK
• Polysulphone	PSU
• Polyether imide	PEI

Examples of parts:

- Rope sheaves and castors
- Guide rollers
- Deflection sheaves
- Friction bearings
- Slider pads
- Guide rails
- Gear wheels
- Sprocket wheels
- Spindle nuts
- Curved feed tables
- Feed tables
- Feed screws
- Curved guides
- Metering disks
- Curved disks
- Threaded joints
- Seals
- Inspection glasses
- Valve seats
- Equipment casings
- Bobbins
- Vacuum rails/panels
- Stripper rails
- Punch supports

Information on how to use this documentation

All calculations, designs and technical details are only intended as information and advice and do not replace tests by the users in regard to the suitability of the materials for specific applications. No legally binding assurance of properties and/or results from the calculations can be deduced from this document. The material parameters stated here are not binding minimum values, rather they should be regarded as guiding values. If not otherwise stated, they were determined with standardised samples at room temperature and 50% relative humidity. The user is responsible for the decision as to which material is used for which application and for the parts manufactured from the material. Hence, we recommend that practical tests are carried out to determine the suitability before producing any parts in series.

We expressly reserve the right to make changes to this document. Errors excepted.
You can download the latest version containing all changes and supplements as a pdf file at www.licharz.de.

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For further information, detailed catalogs are available:

- Information on Licharz machining capabilities of component parts
- Brochure „Material Guiding Values / chemical Resistance“
- Product information on semi-finished products of PA, POM und PET
- Delivery programme

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