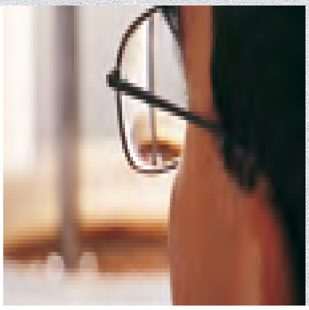
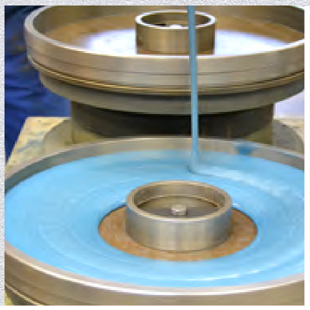
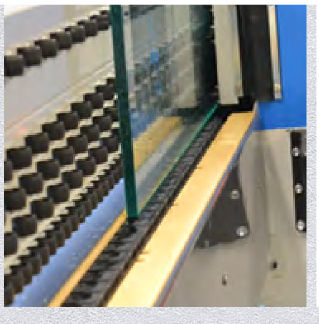
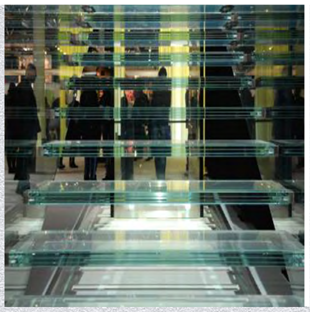
ARTIFEX
Elastisches Schleifen und Polieren
Elastic bonded Abrasives





Finishing of glass edges with elastic bonded abrasives

ARTIFEX Dr. Lohmann GmbH & Co. KG
Feldstrasse 8 · DE-24568 Kaltenkirchen, Germany
Phone: +49 (0) 4191 935-0
info@artifex-abrasives.de
www.artifex-abrasives.de

Edition 08/2014/1

ABSTRACT

Floatglass is used in a wide variety of applications such as construction of buildings, furniture, bathroom interiors and many other items of our everyday life.

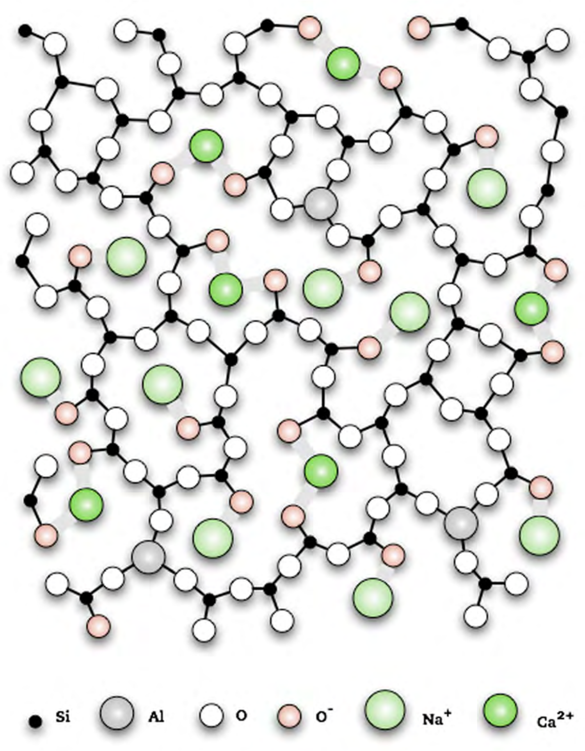
Next to its design and color, perfectly polished edges are a vital requirement. Grinding and profile creation are carried out on single or double edger processing machines, for which metal and resin bonded diamond cup wheels are established tools.

In order to finish the edge of the glass, elastic bonded abrasives with different grain sizes are used.

The final finish for a high gloss polish is achieved using cup wheels containing Cerium Oxide in a resin or rubber bonding.

The result is a perfect gloss finish.

Glass can be seen as a form of frozen liquid which has an amorphous structure and thus, in contrast to other materials, no crystallise[1]. The chemical composition of floatglass is defined in EN572[2]:



Structure of Soda-lime glass
(Foto: www.wikipedia.org/wiki/glas)

Diagram pursuant to[3]

SiO2:	69 - 74%
Na2O:	12 - 16%
CaO:	5 - 12%
MgO:	0 - 5%
Al2O3:	0 - 003%

This is so-called soda-lime glass. Production[4] of floatglass starts with the melting of a raw material mixture at approx. 1560 °C. After this, the glass melt is fed to a float bath of liquid tin. The mass floats as an endless strip on a level tin bath. This results in a coplanar, distortion-free glass sheet of high optic quality. Slow cooling follows, and then quality control and the cutting of panels of normally 3 x 6 m.
Floatglass made in this way has a density of around 2.5 g/cm3 and in addition to its tensile strength of 30 MPa also has an elasticity module of 70,000 MPa[5] .
Many products of everyday life are made from floatglass: mirrors, shower cubicles, glass cabinets, shelves, stove tops, oven windows, flooring and wall covering, balcony parapets and steps.

MASCHINES FOR FLOATGLASS PROCESSING

After cutting, processing of floatglass is made either on a single or double (two opposite edges are processed here simultaneously) edge grinding machines.

Single edger grinding machine Neptun
(Foto: Artifex)

Normally diamond cup wheels are used to prepare the edge for polishing.
Initially, coarse, partially segmented diamond wheels are used in metallic bond (D107 and then D76). Grinding is completed with a fine (D54) metal or a (D64) resin bonded grinding cup.
Arriss-grinding is made with metal bonded cups in D54.
The entire process is cooled with water to which chemical additives (corrosion protection, settling accelerator etc.) may be added.

Pre-finishing is made using various tools in elastic bonding.
One typical grain grading starts in aluminum oxide in F40, then works with aluminum oxide F60 and finally with fine aluminum oxide grains (F120 or F180) for a good , industrial gloss finish‘.

If the resultant glass edge is to have a high-gloss finish, in the final station either a felt cup and a cerium suspension (in an extra cycle) or a cerium finishing cup is applied. Very hard and yet elastic tools with special aluminum oxide (F400) in resin bonding are normally used for arriss finishing.

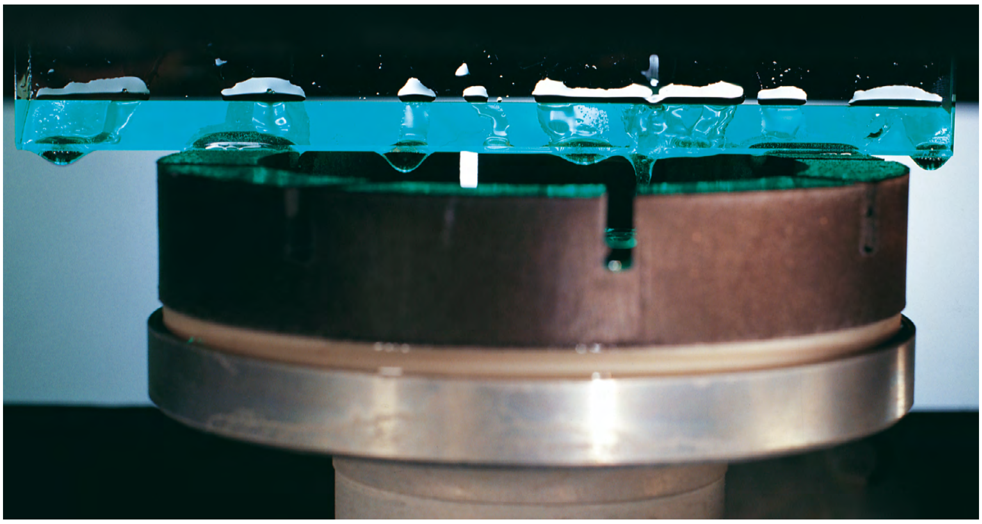
Double edger grinding machine Benteler
(Foto: Benteler)

On completion of the edges, further processing steps follow such as the attachment of drillings, washing and, if required tempering for the production of safety glass (ESG). This is made i.a. in fully automatic production lines which are fed at the beginning with ready cut glass and at the end provide completely processed and cleaned components onto a pallet.

While pre-grinding with diamond cup wheels can be seen as a ‚genuine' grinding process – which is confirmed by the rough surface and the glass powder in the cooling water discharged – the processes in the following – pre-finishing have not, to our knowledge, yet been definitively clarified.
Klocke and König[6i] discuss 4 different hypotheses:

- The cutting hypothesis:
  The harder finishing agent generates very fine crack systems or micro chippings on the glass surface.

- The flow hypothesis:
  The surface finish tips of the glass surface are leveled out via plastic deforming as a result of the pressure applied and frictional heat.



Elastic bonded tool in action
(Foto: Artifex)

- The chemical hypothesis:
  Water used as a cooling lubricant causes corrosion of the glass surface in a peripheral area, accelerated by the polishing agent[7].

- The Friction-Wear hypothesis:
  In addition to mechanical effects, chemical effects also emerge when the glass surface dissolves in water. The latter is caused by the presence of energetic flaws in the crystal lattice of the finishing agent. There is friction between the grain and the surface.

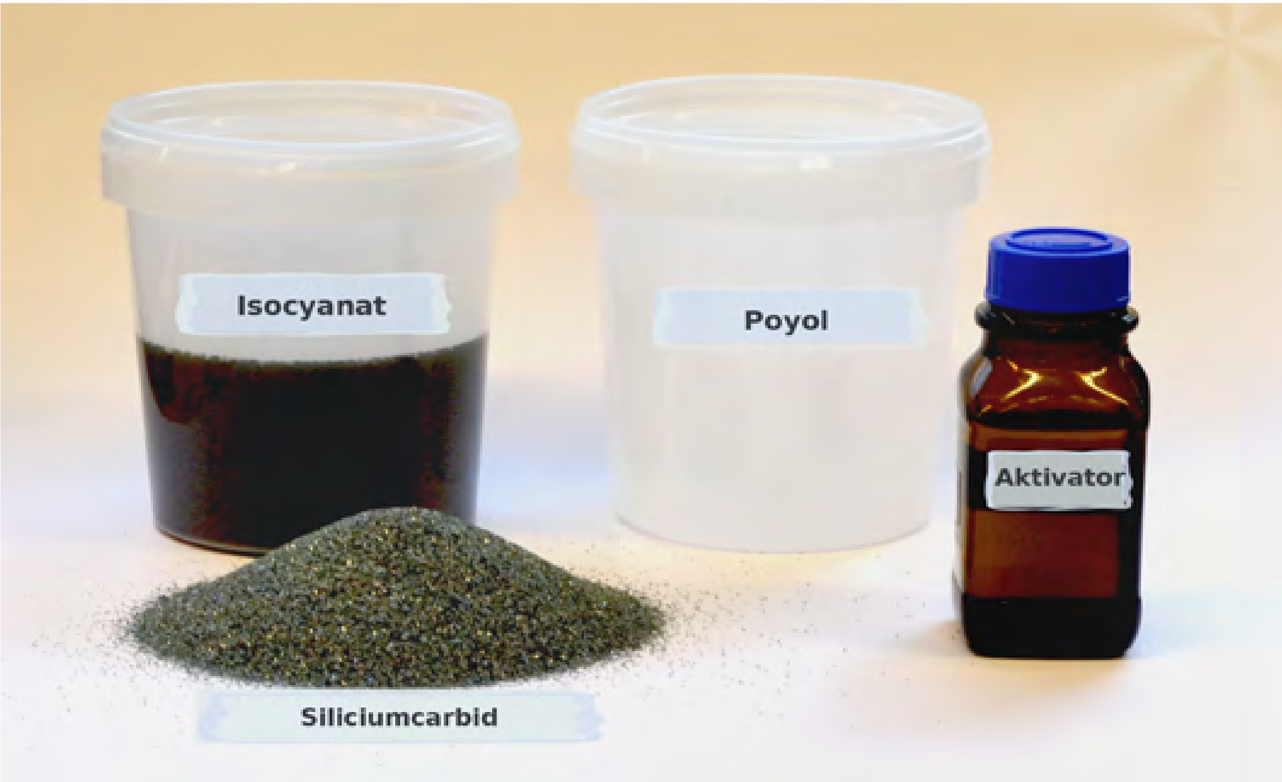
The chemical composition of the elastic pre-finishing tools with the binding agent of polyurethane or rubber and abrasive grain of aluminum oxide excludes such a chemical process. Research in the grinding of optic glass indicates that this involves ductile grinding[8].

This theory is supported by the fact that, in contrast to edges pre-grinded with diamond cup wheel, no cracks, grooves or other traces of brittle chipping formation can be seen. More detailed analysis of this issue is currently being carried out.

Processed glass edges (1 diamond pre-grinding, 2 pre-polishing, 3 High gloss finishing)
(Foto: Artifex)

In the vase of wooden gloss finishing with cerium oxide as finishing agent bonded with rubber or resin, a chemical-mechanical process can be assumed, similar to that of the CMP process via cerium oxide in aqueous suspension.

Elastic abrasives initially comprise common abrasive materials such as silicon carbide, aluminum oxide or other finishing agents as grinding material.
The special tool properties merge with the carriers used:
If you add the grinding material to a matrix of elastic materials such as polyurethane or rubber, you obtain abrasives with suitable elasticity levels for the respective field of application.



Raw materials of polyurethane bonding
(Foto: Artifex)

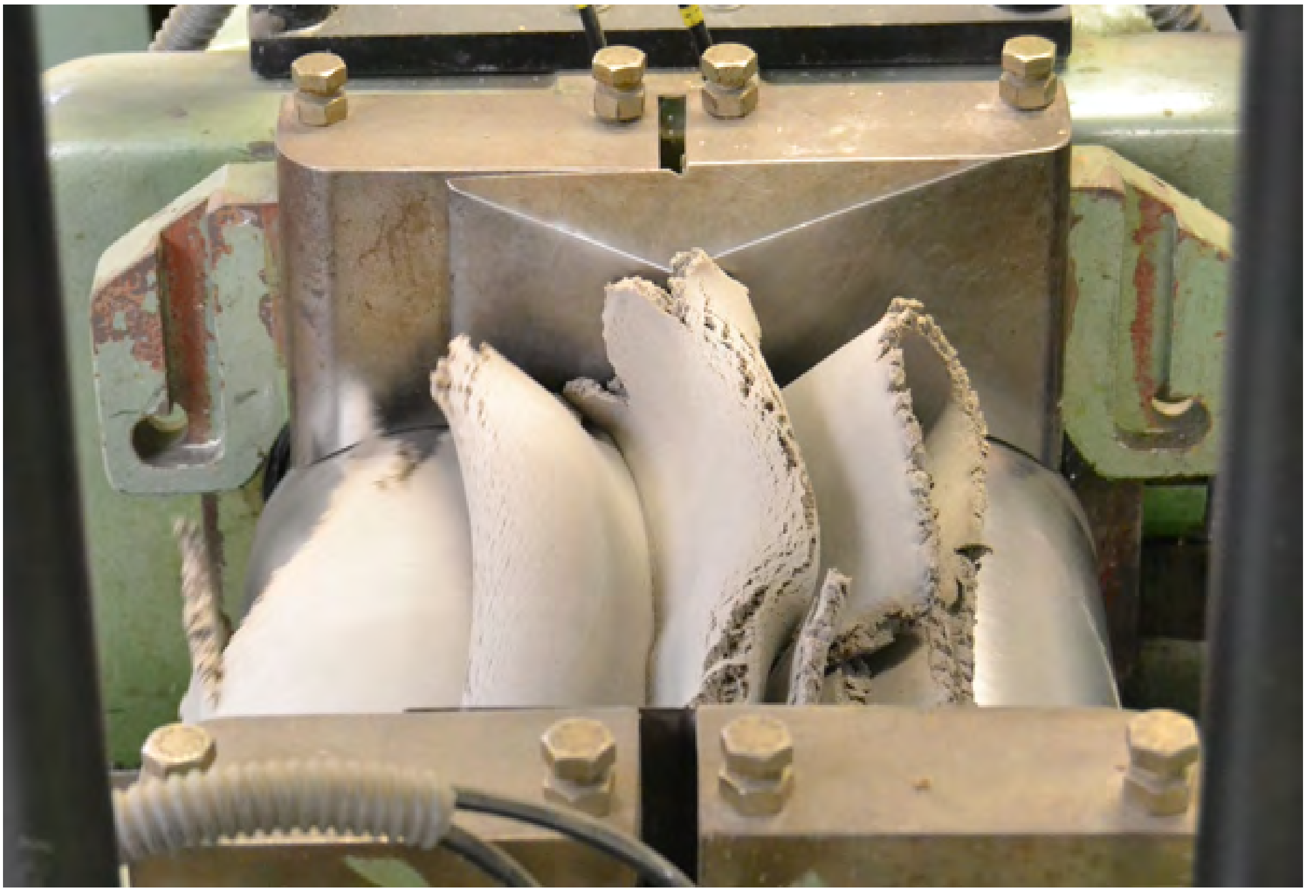
The factors of hardness, elasticity, grain type, grain size and grain share can be combined and varied in different forms. This ensures perfect adjustment to the respective grinding finishing task. Production of elastic abrasives is a chemical process.

Starting with liquid or soft fundamental materials. After blending the abrasives into the bond matrix and abrasives the mixture is fed into moulds and hardened.
The basic material for polyurethane bonds are so-called di-isocyanates and polyols, combined with chain extenders, additives and catalysts. In the case of the production of tools based on polyurethane, normally a liquid bonding system is mixed with the abrasive grain in a continuous process.

Filling the mixture into the mould
(Foto: Artifex)

After filling into the moulds, the system of carrier medium and abrasive reacts, and slowly transforms into the required solid state. The binding system of polyurethane can be seen as a chemical ‚tool box'. The variation of polyol components in particular as the ‚polymer backbone' enables a wide range of properties such as hardness, elasticity and abrasion resistance. This means that bonds from sponge-like soft through to fine porous hard foams can be generated.

Systems with the carrier material of rubber, as is normal in the rubber industry, are made on roller mills.
The fundamental basis for this can be various pure rubbers (natural rubber NR, nitrile rubber NBR, butyle rubber BR, polychloroprene rubber CR i.a.) or mixtures of these.



Production of Rubber bonding on a roller mill
(Foto: ARTIFEX)

In this production process, the abrasive grain and additives are slowly added to the rubber. The resultant blend is then filled into the required moulds and vulcanized with heat. After this, the abrasives are tailored accordingly on processing machines.

For high-gloss finish with cerium oxide a special resin bond has been developed at the Artifex company. The finishing agent is also added to the liquid bonding blend. After hardening and tempering, tailoring is then carried out as described above. Rubber bonded cerium oxide cups are also available.
Elastic bonded abrasives are tools which have been used widely in the glass processing trade for many decades.

Elastic bonded Tools
(Foto: ARTIFEX)

Current developments aim at improving productivity (i.e. higher glass flow rate with the same gloss), better tooling costs (e.g. replacement of rubber bonded tools via better priced bonding systems such as polyurethane) or the creation of high-gloss without the problematic cerium oxide.
As a result, developers and producers are always faced with new challenges.

LITERATURE / BIBLIOGRAPHY

Koch, J.: Polieren von Glaskanten mit elastisch gebundenen Schleifwerkzeugen. Konferenzbeitrag, 4th European Conference on Grinding (ECG) – Schleiftechnik im Wettbewerb, Hrsg.: Brinksmeier, E.; Klocke, F.; Werner, K., Bremen, Germany, 27.-28.11.2014, S. 14-3 – 14-9, ISBN 978-3-00-043766-3.

Author: Dr. Jan Koch, ARTIFEX Dr. Lohmann GmbH & Co. KG, Kaltenkirchen

Bibliography: Literature details in letters with year dates [ARDE01] Ardelt, T. Literaturstelle 1

1 Holleman/Wiberg, Lehrbuch der anorganischen Chemie, deGruyter Verlag, Berlin 1985, S. 779 (Anorganic Chemistry)

2 Glas im Bauwesen- Basiserzeugnisse aus Kalk-Natronsilicatglas- Teil1, Deutsche Fassung EN 572-1, Beuth Verlag, Berlin 2012 (Glass in Civil Engineering – Base products of soda-lime silicon glass)

3 Nach www.wikipedia.org/wiki/glas, 31.5.2013

4 www.glastroesch.de/service/wissen/wissenswertes/floatglassherstellung.html, 31.5.2013

5 Nach www.wikipedia.org/wiki/glas, 31.5.2013

6 Klocke/König, Fertigungsverfahren Schleifen, Honen, Läppen, Springer Verlag, Berlin, 4. Auflage 2005, S. 404 ff. (Production processes Grinding, Honing, Lapping)

7 Fraunhofer IPT, Institut für Gesteinshüttenkunde, Optimierung der chemischen Einflüsse bei der mechanischen Politur von Glas, AIF Forschungsvorhaben 12063N, Aachen 2001, S.19 (Optimization of chemical Influences for mechanical finishing of glass)

8 Dambon, Fraunhofer IPT WZL Aachen, Präzisionsbearbeitung von sprödharten Materialien für optische Anwendungen, Workshop Optokeramiken, Mainz 2010, S. 9-10 (Precision processing of brittle materials)