# THE USE OF SILICA IN THE GLASS INDUSTRY

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**ABSTRACT.** In the technological processes of the silica industries (glass, ceramics and cement), mixtures of raw silica materials are treated at high temperatures. The quartz is relatively spread, but very little used in the glass industry due to its high price and its hardness. The most used raw material is the siliceous sand, in the form of large beddings, containing as well variable quantities of other materials. The raw materials presented are dosed and homogenized in an Eirich type mixer. The melting is done in glass tank furnaces at 1450 – 1500 $^0$C, and the molding is realized by pipe blowing or by pouring into casting boxes. The annealing of household glassware and of the overlaid one is done in annealing furnaces at temperatures in the range of 500 - 550 $^0$C. The products are then decorated and polished. After polishing, the products are sorted and stored, packed for delivery. In Romania, there are various procedures for the decoration of glass products: the use of colorants and the overlaying of intensely colored glasses over the white household glass.

## ПРИЛОЖЕНИЕТО НА КВАРЦА В СТЪКЛАРСКАТА ПРОМИШЛЕНОСТ

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**РЕЗЮМЕ:** В технологичния процес на силикатното производство (стъкло, керамика, цимент), комбинациите от кварцови суровини се третират при високи температури. Кварцът е сравнително широко разпространен, но в чистият му вид е много малко използван в стъкларската индустрия, поради по-високата му цена и твърдост. Най-използваната изходна суровина е кварцовия пясък, който съдържа и други, не по-малко важни за силикатното производство, суровини. Основните изходни суровини са дозирани и добре размесени чрез хомогенизатор от типа „Eirich". Топенето е извършено в пещ при температури 1450-1500 $^0$ C, а формоването е осъществено чрез издухване или отливане във форми. Закаляването на домакинската стъклария и нейното покритие се извършва в закаляващи пещи при температури между 500 – 550 $^0$C. След този процес продуктите се полират и декорират. Така готовите продукти се сортират, опаковат и складират. Начините за декориране на продукти от стъкло в Румъния са различни: използват се пигменти и покрития от интензивно оцветени стъкла над бяло домакинско стъкло.

## Introduction

In the peripheral crust of the Earth, the silica is predominant and reaches 95% of the lithosphere matter. In the lithosphere, $SiO_2$ is a „lithophilious" acid which combines various basic oxides such as: $Al_2O_3$, $Fe_2O_3$, MgO, CaO, $Na_2O$, $K_2O$ etc.

In the technological processes of the silica industries (glass, ceramics and cement), mixtures of raw silica materials are treated at high temperatures and, following the reactions that take place, some technical silica products are obtained. In Figures 1, 2 and 3 are presented silica structures (Mackenzie J. D. 2003).

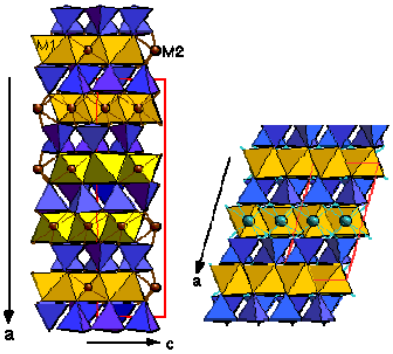


**Fig. 1 – Silica with chain and ribbon structure**

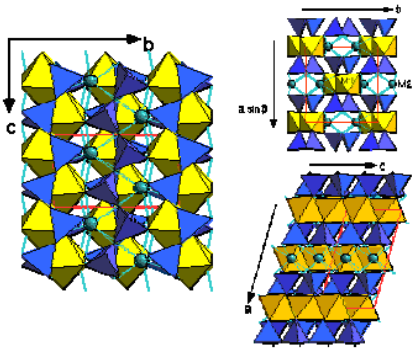


**Fig. 2 – Clinopyroxenes**

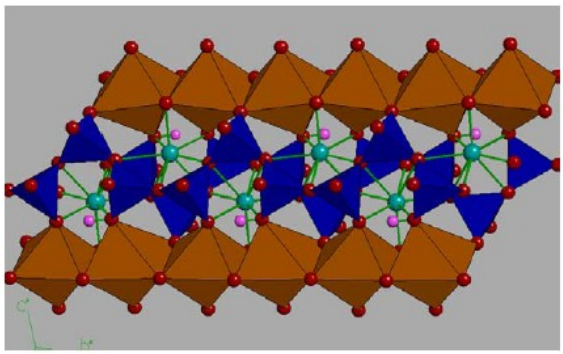

**Fig. 3. Pyroxenes chain structure**

It is observed an analogy with the formation of rocks in nature, presented in Figure 4 (Şerban, S. 1968) where the reactions took place at high temperatures, but within the Earth magma. From this point of view, the technical silica may be considered true synthetic rocks.

The physical and chemical properties of technical silica depends on the nature of the mineral constituents and on their proportion (Baltă P. 1984).

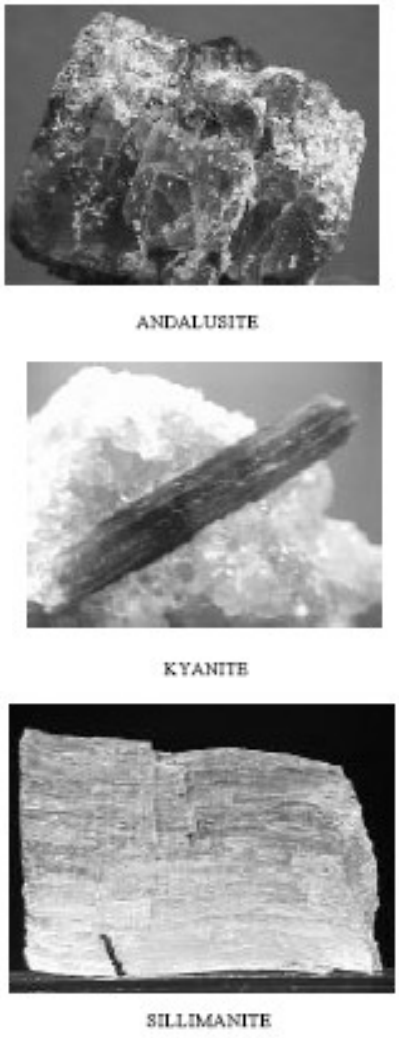


**Fig. 4. Alumino-silica**

In pure state, $SiO_2$ is found under the form of quartz, namely crystal, quartz and siliceous sand. The same order is kept for the decrease of the purity level and for the increase of the bedding size. The crystal is a very expensive raw material used for special kinds of glass, the transparent quartz glass.

The quartz is relatively spread, but very little used in the glass industry due to its high price and its hardness. The most used raw material is the siliceous sand, in the form of large beddings, containing as well variable quantities of other materials. From the point of view of the specific weight, the component minerals are grouped into two classes: the light class and the heavy class.

The main component of the light class is the quartz, reaching 99%. The light class also includes feldspar, the rock which, by its degradation, formed many of the sand beddings such as kaolin, one of the feldspar decomposition products.

The heavy class is reduced quantitatively, but it contains numerous minerals with oxides coloring the glass in un-wanted nuances, among which an important place is detained by iron minerals: hematite – $Fe_2O_3$; limonite $Fe_2O_3$ and $H_2O$; magnetite – $Fe_3O_4$, ilmenite – $FeTiO_3$ and others. In this class, the iron oxides represent approx. 15% and $Cr_2O_3$ approx. 2%. These oxides, as well as others such as $TiO_2$, $V_2O_5$ etc. are not wanted due to their dyeing action, and the zirconium oxide due to its refractoriness which makes it stay under the form of crystalline inclusions in all products, glass included. In some beddings, the quartz granules are covered with a fine film of iron hydroxide which may contain other materials such as: Mn, Ni, Cu, Zn. In the sand there may be some variable quantities of organic substances such as: vegetal wastes, humic acids which, when melting the glass, may create a needed reductive environment.

The paper presents the use of silica in obtaining the household glassware and overlaid glasses at the glass factory STAR GLASS Târgu – Jiu.

## Experimental part

Table 1 presents the oxidic composition of the white and blue glasses which is obtained at the glass factory STAR GLASS Târgu – Jiu.

Table 1
*The oxidic composition of the glasses*

| Number | Component | White glass (% grams) | Blue glass (% grams) |
|---|---|---|---|
| 1 | $SiO_2$ | 73.37 | 60.96 |
| 2 | $B_2O_3$ | 0.26 | 2.83 |
| 3 | $Al_2O_3$ | 0.29 | 0.23 |
| 4 | $Na_2O$ | 13.95 | 13.20 |
| 5 | $K_2O$ | 3.04 | 4.41 |
| 6 | CaO | 8.36 | 3.84 |
| 7 | MgO | 0.7 | 0.1 |
| 8 | PbO | - | 14.41 |
| 9 | $Fe_2O_3$ | 0.03 | 0.02 |

The raw materials presented in Table 2 are dosed and homogenized in an Eirich type mixer. The melting is done in glass tank furnaces at 1450 – 1500 $^0$C, and the molding is realized by pipe blowing or by pouring into casting boxes. The annealing of household glassware and of the overlaid one is done in annealing furnaces at temperatures in the range of 500 - 550 $^0$C.

The products are then decorated and polished. After polishing, the products are sorted and stored, packed for delivery. Table 2 presents the oxidic composition of the raw materials.

Table 2
*The oxidic composition of the raw materials chosen based on the documentation of the Glass Factory Tg – Jiu*

| Raw material | Oxides components % in weight | | | | | | |
|---|---|---|---|---|---|---|---|
| | $SiO_2$ | CaO | $Na_2O$ | $B_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | Other compounds |
| Sand | 98,9 | 0,51 | - | - | 0,3 | 0,13 | - |
| Lime-stone | 1,47 | 53,9 | - | - | - | 0,10 | 0,63 |
| Soda | - | - | 57,2 | - | - | - | 0,3 |
| Borax | - | - | 16,2 | 83,7 | - | - | - |
| Alu-mina | 0,4 | 0,35 | - | - | 97,9 | 0,05 | - |

## Results and discussions

The glass factory STAR GLASS from Târgu – Jiu produces household glassware and the private factory TOPI GLASS produces overlaid glass articles, of different colors, presented in Figures 5, 6, 7 and 8.

**Fig. 5.**

**Fig. 6.**

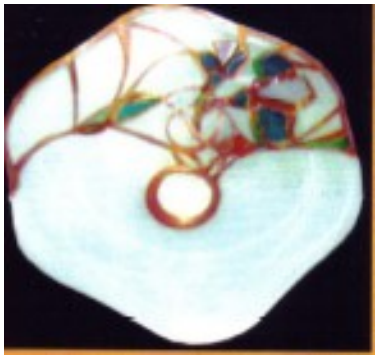

**Fig. 7.**

**Fig. 8.**

The overlaid glass articles are decorative products and among the decorative techniques might be reminded the glass spiral decoration colored at heat.

In Romania, there are various procedures for the decoration of glass products: the use of colorants and the overlaying of intensely colored glasses over the white household glass.

## Conclusions

The glass industry is mainly based on $SiO_2$ which constitutes the main raw material.

The obtained household glass assortments and overlaid products are exported abroad, this proving the development of the two glass factories from the Gorj County.

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