

## EUROPEAN QUALIFYING EXAMINATION 2018

# Paper A

This paper comprises:

- |   |                           |               |
|---|---------------------------|---------------|
| * | Letter from the applicant | 2018/A/EN/1-7 |
| * | Document D1               | 2018/A/EN/8   |
| * | Document D2               | 2018/A/EN/9   |



Company: Ins-Glass GmbH

Address: Klimaweg 123

Bad Silizium

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Dear Madam or Sir,

10 **[001]** Our technical firm deals with building elements such as windows and glass  
facades. We would like to protect our latest development with a patent. We would also  
like to license this future patent. Glazing manufacturers could be possible licensees. We  
therefore ask you to submit a patent application with the widest possible scope of  
protection. Currently our financial means are limited. Additional claim fees should not be  
due.

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**[002]** We can use our new method to create protrusions on the surface of glass panes.  
These glass panes can be used in Vacuum-Insulated-Glass (VIG) glazing.  
VIG-glazing is a special kind of glazing composed of insulating glass.

20 **[003]** Insulating glass is known in the art. It provides protection from cold and noise. An  
insulating glazing comprises two or more, for example three, glass panes, that are  
mounted spaced apart in a frame. The frame hermetically seals the spaces between the  
panes which in conventional insulating glazing are filled with a gas like krypton or argon.  
For example, windows can be manufactured with such insulating glazing.

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**[004]** Recently VIG-glazing was proposed for special applications. VIG-glazing  
comprises mainly the same components as conventional insulating glazing. In contrast  
to the latter, the spaces between the panes are not filled with gas but are under vacuum.  
We consider a pressure of less than 1 atmosphere a vacuum.



**[005]** In order to prevent the glass panes from touching each other due to the vacuum applied during manufacturing of the insulating glazing, spacers must be provided between the panes. These are distributed over the panes in the required amount. They are typically elements not belonging to the glass panes and are made of plastic, aluminium, ceramics, or glass. These spacers are applied to the glass panes in a separate manufacturing step and are attached with glue for example.

**[006]** Our new method allows manufacturing the spacers directly on the glass panes. Therefore, the separate steps of manufacturing and mounting the spacers are eliminated. In addition, the spacers are manufactured from the glass pane itself. They thus have the same composition as the glass pane. Compared to conventional methods, this method is simpler and less costly and delivers glazing of improved quality compared to conventional glazing. There is for example no reduction of the transparency of the glass pane by the spacers.

**[007]** Our spacers are made by irradiating the glass panes with lasers. The energy delivered by the lasers leads to local heating and when the working temperature of the glass is reached, a flowing of the glass. Due to the rise in volume of the glass in the liquid phase, a convex protrusion forms at the surface of the glass pane. When the laser irradiation is stopped, the glass solidifies almost immediately and the protrusion on the surface persists. The irradiation can be repeated at one or more other locations of the glass pane in order to obtain a glass pane with several protrusions distributed over the glass pane. These protrusions can be used as spacers.

**[008]** Conventional window glass has only low absorbency at wave lengths in the ultraviolet (UV) and infrared (IR) ranges. Our method employs photo-induced absorption of the glass. We have annexed document D1 for a more detailed illustration of photo-induced absorption. In summary, photo-induced absorption is a modification of the absorption properties of substrates like glass by irradiation.



**[009]** Contrary to the explanation in D1, we did not succeed in our first attempts to heat conventional window glass to the working temperature locally with a UV range continuous wave laser. We have also had a corresponding negative result with a conventional IR range continuous wave laser. We think that sufficient heating can only  
5 be achieved through a long irradiation time. Such a method would however not be economical.

**[010]** We have used pulsed UV- and/or IR-lasers in our subsequent trials. We were able to achieve photo-induced absorption in window glass. The glass was heated by  
10 irradiation with pulsed UV- and/or IR-lasers to the point that it started to flow locally.

**[011]** The irradiation can be done with UV-lasers alone, IR-lasers alone, or with a combination of UV- and IR-lasers. The use of IR-lasers has been proven to be advantageous when protrusions are to be produced on both surfaces of a glass pane.  
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**[012]** In Figure 1 we have provided you with a schematic diagram of the minimum setup for creating spacers on glass panes. A laser 1 emits laser beam 2. The laser beam 2 impinges on a glass pane 3 arranged with a distance D relative to laser 1 and having a first surface 4 facing the laser 1 and a second surface 5 facing away from the laser 1. If  
20 the glass pane 3 is oriented perpendicular to the plane 2 of the laser 1, the result is a protrusion, which forms a monolithic structure with the glass pane 3, with a circular base on the surface 4 of the glass pane 3 facing the laser 1. Monolithic means that the glass pane and protrusion form a single unit. Such arrangements for irradiating surfaces with lasers are furthermore known to persons skilled in the art.



**[013]** In summary, the method consists of irradiating a glass pane with a laser beam to create a protrusion at a first location on the surface of the glass pane facing the laser, solidifying the protrusion by terminating the irradiation, and repeating the irradiation and solidification at at least one location, different from the first location, on the surface of the glass pane facing the laser. In order to achieve good optical properties, it is furthermore essential that the protrusions have a convex shape. By convex shape we are referring to the form of a hemisphere that might also be flattened at its upper part. By using the convex shape, an improvement in transparency of 20 to 40% is achieved with respect to known glazing. Other forms diverging from the convex shape still allow transparencies that are 10% better than said known glazing. An improvement of 10% can also be achieved with glass hemispheres glued to the glass pane.

**[014]** We can generate a number of protrusions on the surface of glass panes with the above described method. The simplest VIG-glazing, so called double VIG-glazing, consists of two glass panes. For them, a glass pane having protrusions is assembled with a glass pane without protrusions in a frame to form a double VIG-glazing. There is also the possibility of assembling two glass panes having protrusions with one pane without protrusions in a frame to form a triple VIG-glazing.

**[015]** In order to ensure transparency of such a triple VIG-glazing at all possible view angles, it is necessary to ensure that the protrusions on the two glass panes that have them are arranged such that they are substantially coincident in the assembled glazing. This can be readily achieved by control mechanisms during the irradiation of the glass panes. It is important to ensure that possibly necessary adjustments during the assembly of the triple VIG-glazing do not have the consequence that the protrusions in the completed triple VIG-glazing are no longer substantially coincident.



**[016]** Despite their complicated assembly, triple VIG-glazing has undeniable advantages in regard of noise abatement and energy savings.

5 **[017]** Our method is also suitable to provide protrusions on both surfaces of a glass pane. We have provided you with a schematic of such a part in Figure 2. For such a glass pane, the previously described steps of our method are repeated on the second surface 5, different from the first surface 4 of the glass pane 3. This can be achieved by turning around the glass pane 3 in order to irradiate the second surface 5 or by supplying two lasers, one on each side of the glass pane. Heating and thus possible deformation of the existing protrusions on the first surface 4 must be avoided. For the sake of transparency however, the protrusions on both sides must be arranged substantially coincidentally also in this case. As mentioned above, the exclusive use of pulsed IR-lasers has been proven to be advantageous.

15 **[018]** The height of the protrusions is influenced by a number of factors, like the energy of the laser, the repetition rate of the laser, the irradiation time, and the glass quality of the pane. It is known from the conventional spacers in insulating glazing that the protrusions should have a height  $H$  of 100  $\mu\text{m}$  or more so that satisfactory insulation properties can be expected. As mentioned above, the protrusions must have a convex shape in order to achieve good transparency of the glass pane. We have realized that this cannot be simply achieved through the solidification of the protrusion upon ending the irradiation. Rather it is necessary that the solidification occurs while a stream of cooling air is provided over the surface of the glass pane. A convex form of the protrusion can only be achieved with such cooling.



**[019]** In order to control the height of the protrusions, in one of our trials we formed them against an obstacle element. This obstacle element must be transparent to the laser and may not influence it. Sodium chloride and quartz glass for example are suitable materials for such obstacle elements. Advantageously, the obstacle element is in the form of a plate that is spaced apart from the glass pane on which the protrusions are created.

**[020]** The protrusions that we obtained using the obstacle elements to limit the height of the protrusions have the form of a hemisphere flattened at its upper part. In addition, local stresses and subsequent possible damage at the contact area between the glass panes are avoided by this protrusion shape. The contact area between the opposing glass panes is nevertheless not enlarged to a degree that the heat insulation properties of the VIG-glazing are compromised.

**[021]** We have already manufactured prototypes of glazing for test purposes using our method. We thus manufactured a double VIG-glazing using conventional window glass that was treated with pulsed UV-laser to generate the protrusions. Another prototype is a triple VIG-glazing. In this glazing the protrusions are located on both surfaces of the middle glass pane.

**[022]** On the occasion of a trade show we have received the annexed announcement D2 regarding VIG-windows. We do not regard this announcement that was distributed as an advertisement to existing and potential private and corporate customers as particularly relevant.



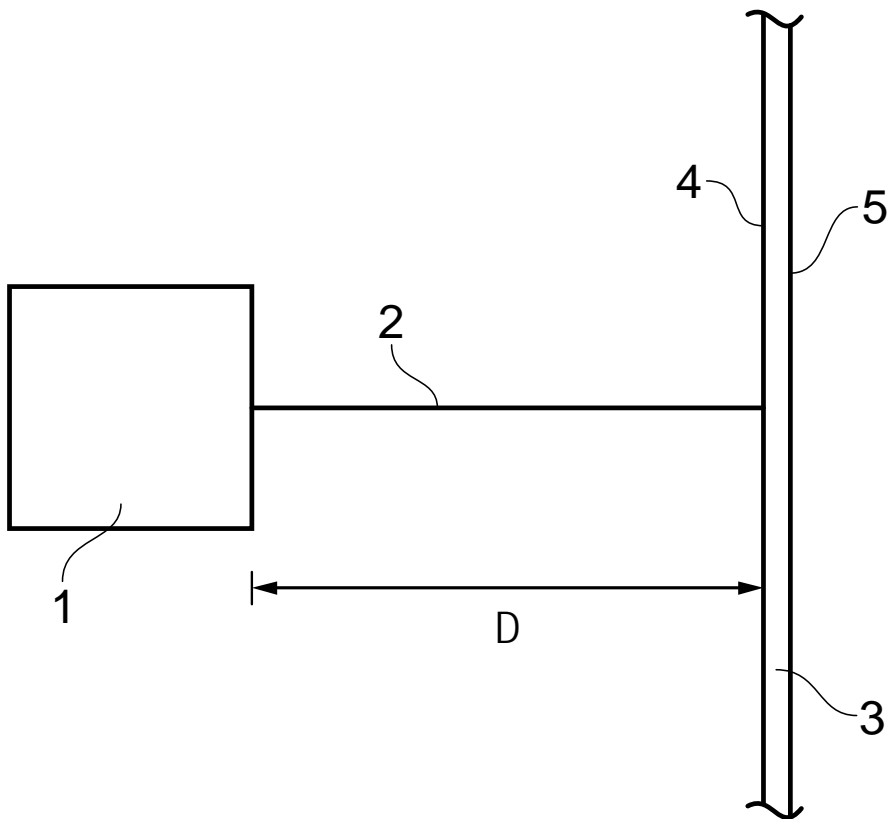


FIG. 1

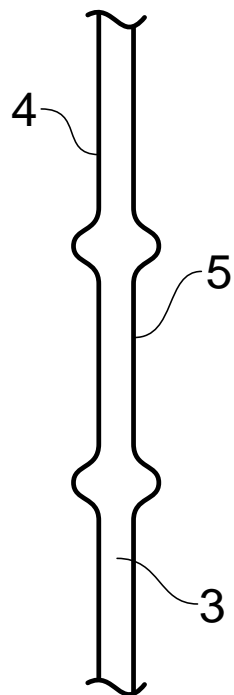


FIG. 2



## Document D1: Science and Technology

**[001]** Transparent substrates like glass can have very low absorbency for electromagnetic radiation in the ultraviolet (UV) and infrared (IR) ranges. It is possible to  
5 raise the absorbency of such substrates for electromagnetic radiation in the UV- and IR- ranges by irradiating them with laser beams. It is quite possible to raise the absorbency to values 50% larger than the initial value of an unirradiated substrate.

**[002]** This effect is due to so called photo-induced absorption. Photo-induced absorption  
10 is caused by chemical elements in the transparent substrate, which, when irradiated with a laser having a suitable wavelength, change, for example, their oxidation state. This change of the oxidation state entails a change of the absorption properties and the absorbency of the substrate is raised locally.

**[003]** UV- and IR-lasers, both continuous wave laser and pulsed laser, can be  
15 considered for this irradiation.

**[004]** This effect allows heating transparent substrates like glass locally. Glass on the surface of a glass pane was made to flow locally by irradiation. The liquid fraction of the  
20 glass, that has a lower density than the surrounding solid glass, emerges from the surface of the glass pane in the form of an irregular protrusion. This protrusion solidifies as soon as the laser irradiation is terminated.

**[005]** If the laser used for irradiation is moved by a suitable controller across the glass  
25 pane, the protrusions can form patterns. Glass panes can be provided, for example, with integrated superficial logos. Furthermore, the glass panes can be used in other commercial products like Vacuum Insulated Glass (VIG) glazing.



## Document D2: Announcement

**[001]** We are pleased to be able to inform you that by an innovation we have extended our product range of vacuum insulated glass windows (VIG windows).

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**[002]** Up to now we have offered VIG windows consisting of two glass panes of the type double insulation. We can now also offer the VIG windows of the type triple insulation. Due to three glass panes and the two vacuum compartments these windows offer additional benefits regarding noise and thermal insulation.

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**[003]** The VIG windows in the triple insulation variant comprise three glass panes that are mounted spaced apart in a hermetically sealed frame. A middle glass pane is arranged between the room side glass pane and the street side glass pane.

15 **[004]** For the glass plates we use separate convex elements as spacers, that consist of the glass material itself. It is therefore not necessary to use metallic or ceramic elements. We achieve a 10 % improvement in transparency in comparison to windows that are achieved with conventional glass spacers.

20 **[005]** We have optimized the distribution of the necessary spacers on both surfaces of the middle glass pane. Therefore, we are pleased to be able to offer you this innovation at the high-quality level you expect from our products at an advantageous price. See for yourself!

