**[19]** In a further preferable embodiment, the difference of the refractive index $n_d$ between the glass substrate and the microstructure layer $\Delta n_d \leq 0.5$.

**[20]** In this embodiment, diffractive optical elements, DOEs, were designed for applications with lasers and high-power lasers. Used as multi-spot beam splitters, in beam shaping, and beam profile modification, such elements offer endless possibilities in different application fields. The DOE is adoptable for the application in optics, in particular diffractive optical element or refractive optical element, all these optical elements can be in the 3D imaging and sensing fields or the fields that needs the function of depth detection or recognition such as entertainment, posture recognition, tracking of hand articulations, and facial recognition system, augment reality, virtue reality.

**[21]** In a further preferable embodiment, the glass substrate is made of a glass selected from the group consisting of silicate glasses, borosilicate glass, aluminosilicate glasses, aluminum borosilicate glass, soda lime glass and lithium aluminum silicate glass (LAS).

**[22]** In a further preferably embodiment, the microstructure layer consists of a polymer selected from the group consisting of epoxy resins and acrylic resins. Polymer may contain some inorganic material, e.g. $SiO_2$, to increase refractive index of the polymer. But the polymer is not limited to the above mentioned polymers. Any polymer that can form the desired microstructure can be used to make the microstructure layer.

**[22a]** In accordance with another aspect of the present application, there is provided a method of manufacturing the micro-optical element as described herein. The method includes the following steps: providing a glass substrate with a thickness $t \leqslant 1500$ μm, preferably $t \leqslant 1200$ μm, more preferably $t \leqslant 1100$ μm, and wherein the glass substrate has a Total Thickness Variation $TTV \leqslant 40$μm, preferably $TTV \leqslant 30$ μm, more preferably $TTV \leqslant 20$ μm, in particular preferably $TTV \leqslant 10$ μm and most probably $TTV \leqslant 5$ μm; the glass substrate has a thickness tolerance $\delta \leqslant 80$ um, preferably $\delta \leqslant 50$ μm, more preferably $\delta \leqslant 20$ μm, further preferably $\delta \leqslant 10$ μm, in particular preferably $\delta \leqslant 5$ μm and most preferably $\delta \leqslant 2$ μm; and applying a microstructured polymer layer to the glass substrate to form a microstructure layer.

Claims:

**1.** A micro-optical element comprising:

a glass substrate with a thickness t ≤ 1500 μm, preferably t ≤ 1200 μm, more preferably t ≤ 1100 μm;

a microstructure layer formed from polymer imprinted on the glass substrate;

wherein the bonding strength between microstructure layer and glass substrate is higher than 0.5MPa, preferably higher than 1MPa, more preferably higher than 1.5MPa;

the glass substrate has a Total Thickness Variation TTV ≤ 40μm, preferably TTV ≤ 30 μm, more preferably TTV ≤ 20 μm, in particular preferably TTV ≤ 10 μm and most probably TTV ≤ 5 μm;

the glass substrate has a thickness tolerance δ ≤ 80 um, preferably δ ≤ 50 μm, more preferably δ ≤ 20 μm, further preferably δ ≤ 10 μm, in particular preferably δ ≤ 5 μm, and most preferably δ ≤ 2 μm.

**2.** The micro-optical element according to claim 1, characterized in that, the glass substrate has a special number of Non-Bridge Oxygen NBO ≥ 0.3, preferably NBO ≥ 0.5, more preferably NBO ≥ 1, in particular preferably NBO ≥ 1.5 and most preferably NBO ≥ 2,

wherein NBO = $(R_2O + R'O) / (P_2O_5 + Al_2O_3 + B_2O_3 + TiO_2+ZrO_2)$;and/or

a ratio X = $(R_2O + R'O - P_2O_5 - Al_2O_3 - B_2O_3)/(SiO_2 + P_2O_5 + Al_2O_3 + B_2O_3)$, which is more than -0.2, preferably more than 0 and more preferably more than 0.2;

wherein R is alkali metal, including Li, Na, K; and R' is alkali earth metal, including Mg, Ca, Ba; and the glass substrate exhibits a low glue contact angle θg of less than 35 °, preferably less than 25°, more preferably less than 15°.

**3.** The micro-optical element according to claim 1, characterized in that, the glass substrate exhibits a warp ≤ 500 μm, preferably ≤ 100 μm, more preferably ≤ 80 μm, and most preferably ≤ 50 μm.

**4.** The micro-optical element according to claim 1, characterized in that, the glass substrate exhibits a ratio of TTV to glass thickness less than 10 %, preferably less than 8 % and more preferably less than 5 %.

**5.** The micro-optical element according to one of the preceding claims, characterized in that, the glass substrate has a surface roughness Ra ≤ 20 nm, preferably Ra ≤ 10 nm, and more preferably Ra ≤ 5 nm.

**6.** The micro-optical element according to one of the preceding claims, characterized in that, the glass comprising the following composition in mol% based on oxide:

| Components | Proportion (mol%) |
|---|---|

| | |
|---|---|
| SiO2 | 60 – 83 |
| B2O3 | 0 – 12 |
| Na2O | 0 – 13 |
| K2O | 0 – 7 |
| MgO | 0 – 7 |
| CaO | 0 – 10 |
| BaO | 0 – 1 |
| TiO2 | 0 – 4 |
| ZnO | 0 – 6 . |

**7.** The micro-optical element according to one of the preceding claims, characterized in that, the glass substrate has a refractive index $n_d$ in a range from from 1.4 to 2.5, preferably in a range from 1.45 to 1.8 and more preferably in a range from 1.45 to 1.55, preferably in a range from 1.41 to 2.1, preferably in a range from 1.42 to 2.0, preferably in a range from 1.45 to 1.9, preferably in a range from 1.45 to 1.8, preferably in a range from 1.45 to 1.7, most preferably in a range from 1.45 to 1.6.

**8.** The micro-optical element according to one of the preceding claims, characterized in that, the glass substrate exhibits a transmission index $T \geq 90\%$, preferably $T \geq 91\ \%$.

**9.** The micro-optical element according to one of the preceding claims, characterized in that, the glass substrate exhibits a Coefficient of Thermal Expansion $CTE_{20\text{-}300°C} \leq 15 \times 10^{-6}$ /K, preferably $CTE_{20\text{-}300°C} \leq 10 \times 10^{-6}$ /K.

**10.** The micro-optical element according to one of the preceding claims, characterized in that, the glass substrate exhibits a $CTE_{glass}$ with a ration to the $CTE_{polymer}$ of the microstructure layer of $CTE_{polymer}/CTE_{glass} \leq 100$, preferably $CTEp_{olymer}/CTE_{glass} \leq 80$.

**11.** The micro-optical element according to one of the preceding claims, characterized in that, the difference of the refractive index $n_d$ between the glass substrate and the microstructure layer $\Delta n_d \leq 0.5$.

**12.** The micro-optical element according to one of the preceding claims, characterized in that, the glass substrate is made of a glass selected from the group consisting of silicate glasses, borosilicate glass, aluminosilicate glasses, aluminum borosilicate glass, soda lime glass and lithium aluminum silicate glass.

**13.** The micro-optical element according to one of the preceding claims, characterized in that, the microstructure layer consists of a polymer of epoxy resins or acrylic resins.

**14.** A method of manufacturing the micro-optical element according to one of claims 1 to 13, characterized in that the method includes the following steps:

- providing a glass substrate with a thickness t ≤ 1500 μm, preferably t ≤1200 μm, more preferably t ≤1100 μm, and wherein the glass substrate has a Total Thickness Variation TTV ≤ 40μm, preferably TTV ≤ 30 μm, more preferably TTV ≤ 20 μm, in particular preferably TTV ≤ 10 μm and most probably TTV ≤ 5 μm; the glass substrate has a thickness tolerance δ ≤ 80 um, preferably δ ≤ 50 μm, more preferably δ ≤ 20 μm, further preferably δ ≤ 10 μm, in particular preferably δ ≤ 5 μm and most preferably δ ≤ 2 μm; and
- applying a microstructured polymer layer to the glass substrate to form a microstructure layer.

**15.** The method according to claim 14, characterized in that the microstructured polymer layer can be homogenously applied by spin coating, spray coating or deposition.

**16.** The method according to claim 14, characterized in that, the application of the microstructured polymer layer to the glass substrate includes the following steps:

(a) polymer is deposited onto a substrate, and a UV-transparent template is positioned above;
(b) the template is pressed into the polymer layer and cured
(c) the template is released leaving the cured polymer with the imprinted features, to form a microstructure layer.

**17.** The method according to claim 16, characterized in that, the microstructure layer can be cured by UV or thermal heating.

**18.** The method according to one of claims 14 to 17, characterized in that, the microstructure layer can be applied onto two side surfaces of the glass substrate.

**19.** Use of the micro-optical element according to one of claims 1 to 13 as diffractive optical element, refractive lens, mirror, prism, GRIN len, hybrid element, diffuser in 3D imaging/sensor, augmented reality, Virtual reality, cameras, automated manufacturing systems, mobile communications.