SELECTIVE LASER HEAT TREATMENTS FOR MELTING AND CRYSTALLIZATION OF GLASS

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Purpose

The piezoelectric glass ceramic investigated in this study contains fresnoite crystals in a glass matrix and is obtained by crystallization of a parent glass of the SrO-SiO_2-Al_2O_3-K_2O-TiO_2 system. The laser treatment is realized in 2 steps:

1) Creation of an amorphous homogeneous coating from a parent glass crushed in powder ;
2) Crystallization of this amorphous coating.

Lasers characteristics

Laser CF10:

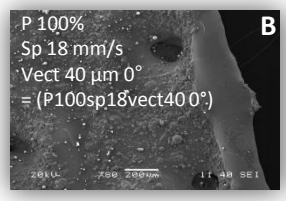
- Solid-state laser
- Yb-doped optical fiber
- P_{max}=8,6 W (cw)
- λ=1071 nm
- Beam TEM_{00} (Gaussian)

Laser Trumark Station 5000 (Trumpf):

- Solid-state laser (Nd-YVO_4)
- P_{max}=22,8 W (cw)
- λ=1064 nm
- Beam: TEM_{00} (Gaussian)

Laser treatment of fresnoite powder compacts

On the surface of the compact realized, squares with 0.5 cm of section has been designed by laser (Figure A).



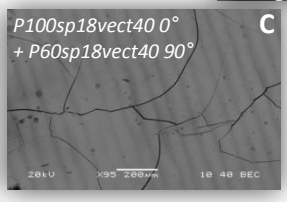
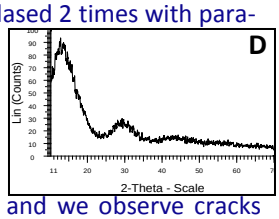


Figure B: An amorphous surface is formed without homogeneity. Some initial powder grains didn't melt correctly.

Figure C: Sample of the figure *C* is lased 2 times with parameters *P100sp18vect40 0°* for the first scan and *P60sp18vect40 90°* for the second scan. We obtained a homogeneous glass surface (confirmed by XRD → figure D).



Cooling of laser treatment is rapid and we observe cracks on the surface.

Devitrification of a glass coating formed by scan laser on compact

1. Scan laser

From samples with laser conditions as figure C, we realized a third laser scan to devitrify these one. The applied energy for the third laser scan had to be increase (vectorization ↘ from 40 to 10 µm). It seems that crystallization didn't appear with minder applied energy because of a lack of time to permit the kinetic of crystallization. Crystallization must be appearing in the sawing of the scan laser when the thermally affected zone cooled.

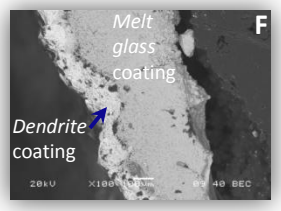
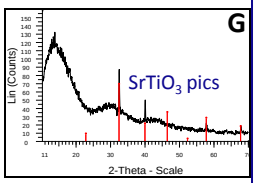


Figure E: Formation of dendrites can be seen.

Figure F: The dendrite structure is about 100 µm (white coating). Under this dendrite structure, a coating of melt glass had a thickness between 250 and 600 µm.

XRD patterns

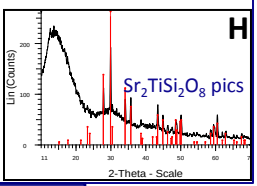
XRD pattern reveal a partial crystallization of $SrTiO_3$ (Fig. *G*) and not $Sr_2TiSi_2O_8$.



2. Furnace treatment

Glass coating with laser parameters as figure *C* were realized.

Crystallization of the glass square was performed by a furnace treatment (5°C/min to 800°C; holding 800°C 1h). XRD pattern reveals partial crystallization of $Sr_2TiSi_2O_8$ (Fig. *H*).



Conclusion

The first results show that suitable scanning conditions make possible to obtain a dense and homogeneous glass powder coating. Devitrification of the glass powder coating may be realized with the laser. Moreover, the XRD patterns and the SEM observations highlight that the coating is only partially crystallized.

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