A NOVEL DENTAL RESTORATIVE GLASS-CERAMIC BASED ON FLUORCANASITE

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Introduction

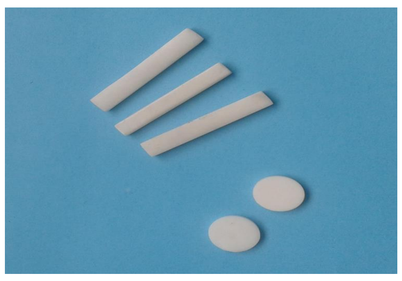
• Fluorcanasite ($K_2Na_4Ca_5Si_{12}O_{30}F_4$) based glass-ceramics (GCs) have been developed recently in order to replace current commercial all-ceramic dental materials (zirconia and lithium disilicate).

• Several compositions based on fluorcanasite system were prepared and the glass formation, crystallization behavior, microstructural and mechanical properties were investigated.

• DTA was used to determine the glass transition (T_g) and crystallization temperatures (T_p). Crystallinity evolution with thermal treatment was followed by XRD. Microstructure of GCs were evaluated by SEM. Vickers microhardness was measured and compared for the different compositions.

• Characterization of flexural strength, fracture toughness and chemical durability will be performed during the next steps of the work. It is expected that results of this study confirm the possibility of obtaining glass-ceramics with satisfactory properties for use in dental restorations.

Fluorcanasite-based glasses.

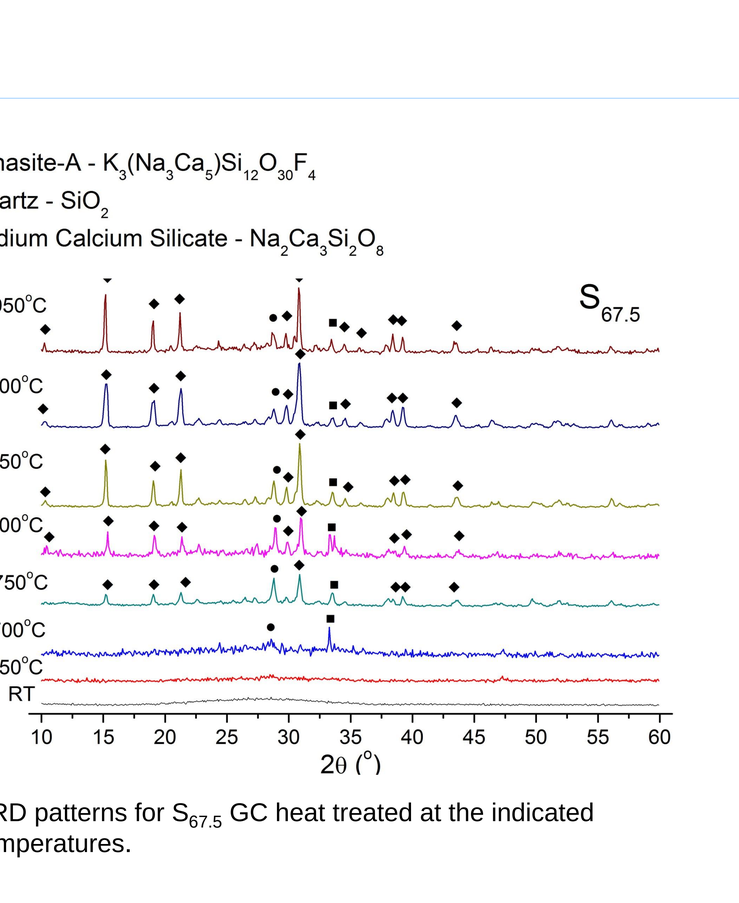


Fluorcanasite-based glass-ceramics.

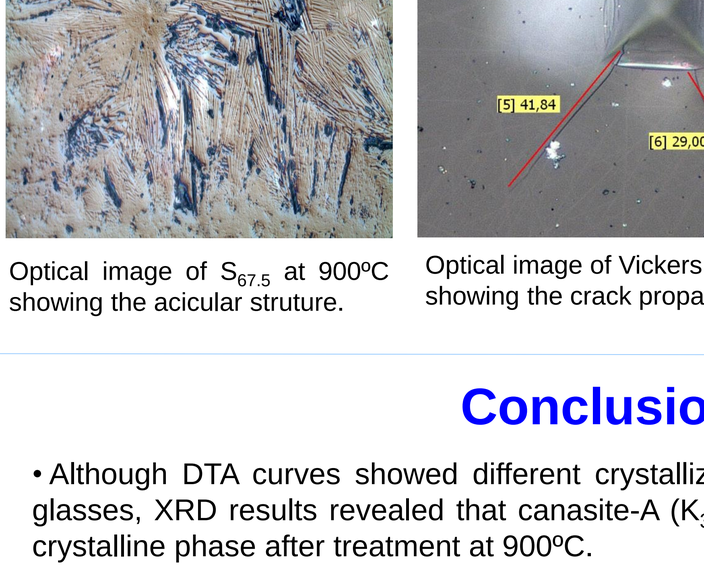
%mol	SiO_2	CaO	Na_2O	K_2O	CaF_2	Al_2O_3	ZrO_2	P_2O_5
$S_{67.5}$	67.5	9.8	6.2	5.5	10	1	-	-
S_{70}	70	8.96	5.36	4.69	10	1	-	-
$S_{67.5}Z_1$	67.5	9.47	5.87	5.17	10	1	1	-
$S_{67.5}Z_{0.5}P_{0.5}$	67.5	9.47	5.87	5.17	10	1	0.5	0.5
$S_{67.5}A_2$	67.5	9.47	5.87	5.17	10	2	-	-

Compositions of different batches

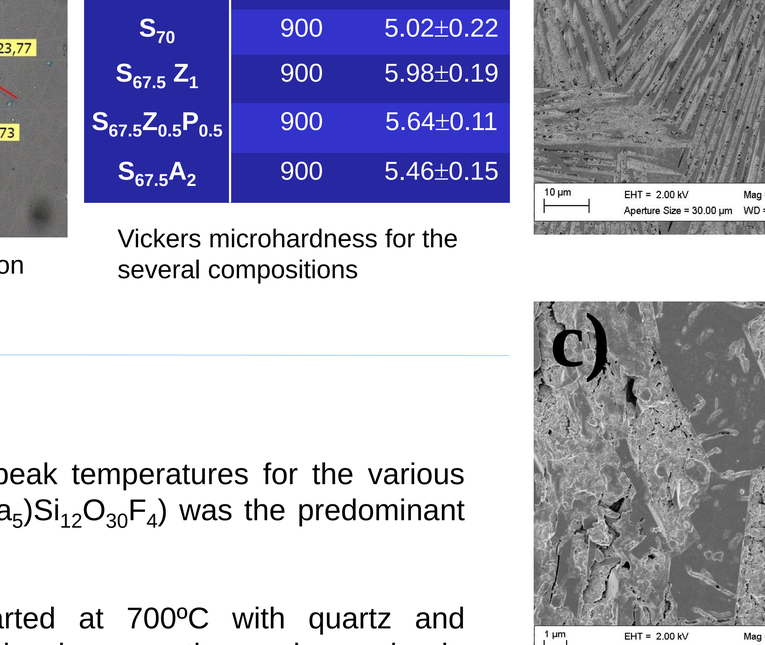
Experimental



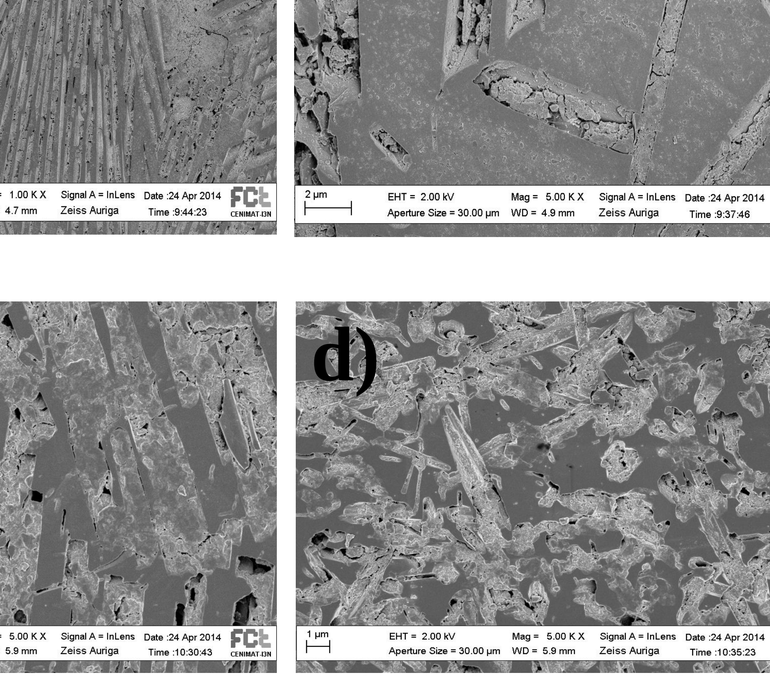
Results



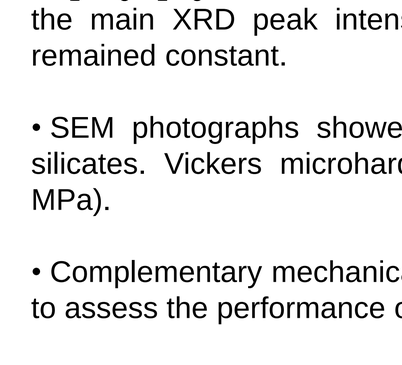
DTA curves for glass powders compositions at 10ºC/min. Glass transition temperature (T_g), crystalliztion peak (T_p), and melt temperature (T_m).



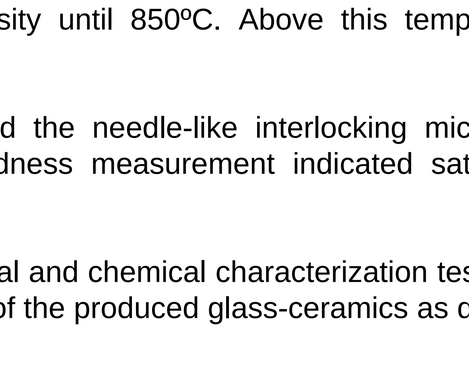
XRD patterns for the several GCs heat-treated at 900ºC.



XRD patterns for $S_{67.5}$ GC heat treated at the indicated temperatures.



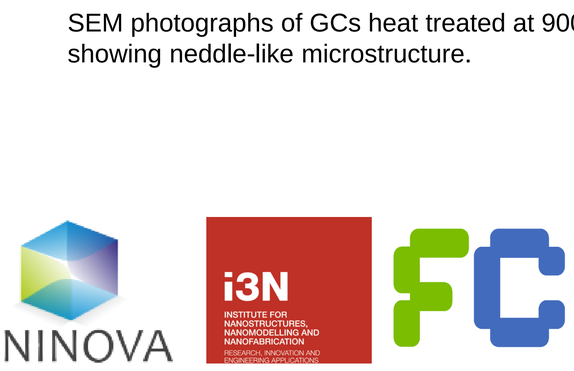
Optical image of $S_{67.5}$ at 900ºC showing the acicular struture.

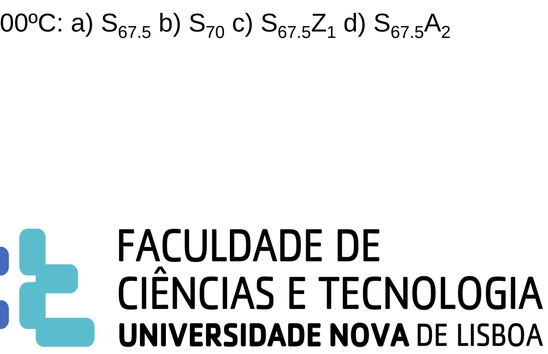


Optical image of Vickers identation showing the crack propagation.

Samples	Temp. (°C)	HV (GPa)
$S_{67.5}$	750	5.11±0.11
$S_{67.5}$	800	4.94±0.17
$S_{67.5}$	900	4.97±0.10
S_{70}	900	5.02±0.22
$S_{67.5}Z_1$	900	5.98±0.19
$S_{67.5}Z_{0.5}P_{0.5}$	900	5.64±0.11
$S_{67.5}A_2$	900	5.46±0.15

Vickers microhardness for the several compositions





SEM photographs of GCs heat treated at 900ºC: a) $S_{67.5}$ b) S_{70} c) $S_{67.5}Z_1$ d) $S_{67.5}A_2$ showing neddle-like microstructure.

Conclusions

• Although DTA curves showed different crystallization peak temperatures for the various glasses, XRD results revealed that canasite-A ($K_3(Na_3Ca_5)Si_{12}O_{30}F_4$) was the predominant crystalline phase after treatment at 900ºC.

• XRD results indicated that glass crystallization started at 700ºC with quartz and $Na_2Ca_3Si_2O_8$ formation. Canasite-A appeared at 750ºC showing a continuous increasing in the main XRD peak intensity until 850ºC. Above this temperature XRD peak intensity remained constant.

• SEM photographs showed the needle-like interlocking microstructure, typical of chain silicates. Vickers microhardness measurement indicated satisfactory values (above 5.0 MPa).

• Complementary mechanical and chemical characterization tests will be carried out in order to assess the performance of the produced glass-ceramics as dental restorative materials.

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