PMMA-BIOGLASS SCAFFOLDS OBTAINED BY PHASE SEPARATION METHOD:ANALYSIS OF ITS STRUCTURE, MORPHOLOGY, MECHANICAL AND BIOLOGICAL PROPERTIES

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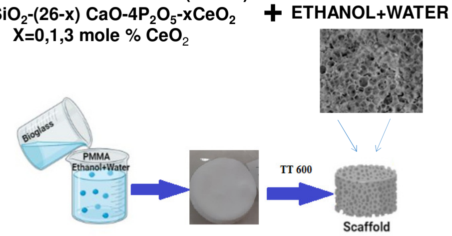
Introduction

The design and engineering of synthetic 3D scaffolds with ordered architectures has recently received particular attention in medical engineering sectors including genetic, and tissue engineering. The synthetic bone graft substitutes can overcome the limitations associated with currents treatments e.g. transmitting infectious diseases and immunological rejection. The scaffold will serve as a template for bone cell regeneration and support the formation of new tissue. While designing a scaffold for bone regeneration, the following properties are essential: biocompatibility, porosity, pore size, surface properties, mechanical properties, and biodegradability.

Experimental

MESOPOROUS BIOGLASS (MBGS)
$70SiO_2$-(26-x) CaO-$4P_2O_5$-xCeO_2
X=0,1,3 mole % CeO_2

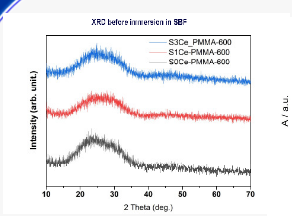
+ 15 % PMMA
ETHANOL+WATER

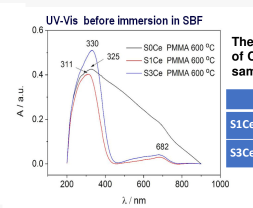


Characterization

- XRD
- FTIR
- UV-Vis Spectroscopy
- SEM
- Porosity
- BET
- Compressive strength
- Bioactivity evaluation
- Scaffold biodegradability
- Biocompatibility evaluation

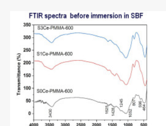
Results



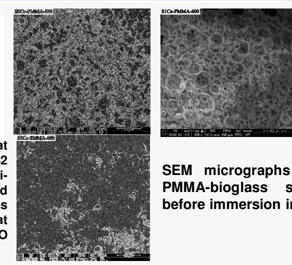


The position of the maximum of the absorption band of Ce^{4+} and Ce^{3+}, of the Gaussian bands, in the doped samples

Sample	$\lambda_{abs, Ce^{4+}}$ / nm	$\lambda_{abs, Ce^{3+}}$ / nm
S1Ce-PMMA 600°C	225 / 256	322
S3Ce-PMMA 600°C	228 / 267	341



The absorption bands at around 1080 cm^{-1} and 482 cm^{-1} correspond to the Si-O-Si stretching and bending vibrations respectively. The band at 598 cm^{-1} is assigned as P-O bending vibrations



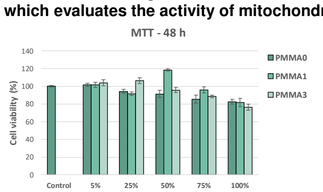
SEM micrographs of the PMMA-bioglass scaffolds before immersion in SBF.

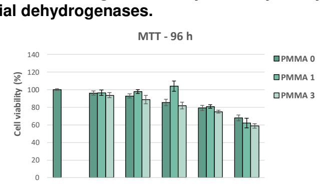
Porosity, BET surface area, and compressive strength of the scaffolds

Samples	Porosity % (Archimedes method)	BET surface area (m^2/g)	Compressive strength (MPa)
S0CePMMA600	46	97	27
S1CePMMA600	54	137	29
S3CePMMA600	52	114	28

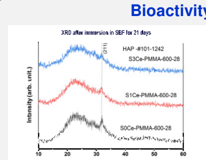
Bioacompatibility evaluation

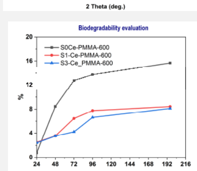
The survival percentage of the fibroblast L929 cells in the presence of thermally treated PMMA- bioglass scaffolds was determined using MTT cell cytotoxicity assay which evaluates the activity of mitochondrial dehydrogenases.

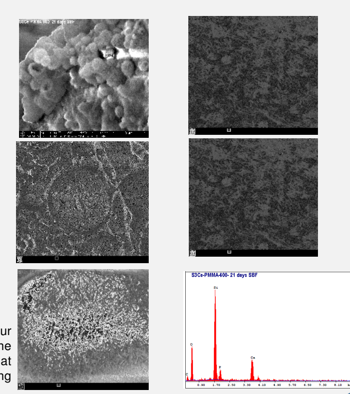




Bioactivity and biodegradability evaluation







The degradation of the scaffold must occur slowly, that sufficient tissue is formed, and the degraded scaffold products can be at levels that can be tolerated by the cells without inducing cytotoxicity.

Conclusions

✓PMMA–MBGs scaffolds were obtained by the phase separation method
✓UV–Vis measurement allowed us to determine the Ce^{3+}/Ce^{4+} ratio in the PMMA-MBGs scaffolds.
✓XRD patterns confirmed the amorphous structure of the thermally treated scaffolds
✓The compressive strength and porosity values classify the obtained scaffolds as promising materials for application as a substitute of cancellous bone.
✓After 5 days of immersion, XRD and SEM analyses revealed the formation of hydroxyapatite (HAP) layer on the surface of the PMMA-bioglass scaffolds
✓In vitro MTT assay revealed the absence of toxicity within the range of 5 – 75 % for PMMA- bioglass scaffolds at both exposure times (48 and 96 h), the percentage of cell viability being above 80%. Cell viability decreased at the highest tested concentration (100%) for all scaffolds.

Acknowledgements

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