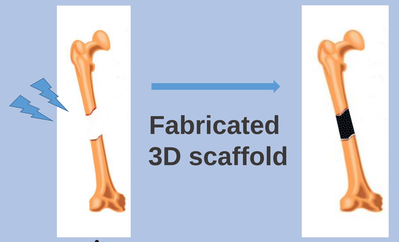
Fabrication and evaluation of 3d printing zirconia composite double-coated with 45S5 bioactive glass

INTRODUCTION

➢ Requirements for bone tissue engineering scaffold

- ✓ ECM mimicking and osteoconductive scaffolds
- ✓ Biocompatible and biodegradable
- ✓ Osteoinductive and angioinductive



➢ Bioglass® 45S5

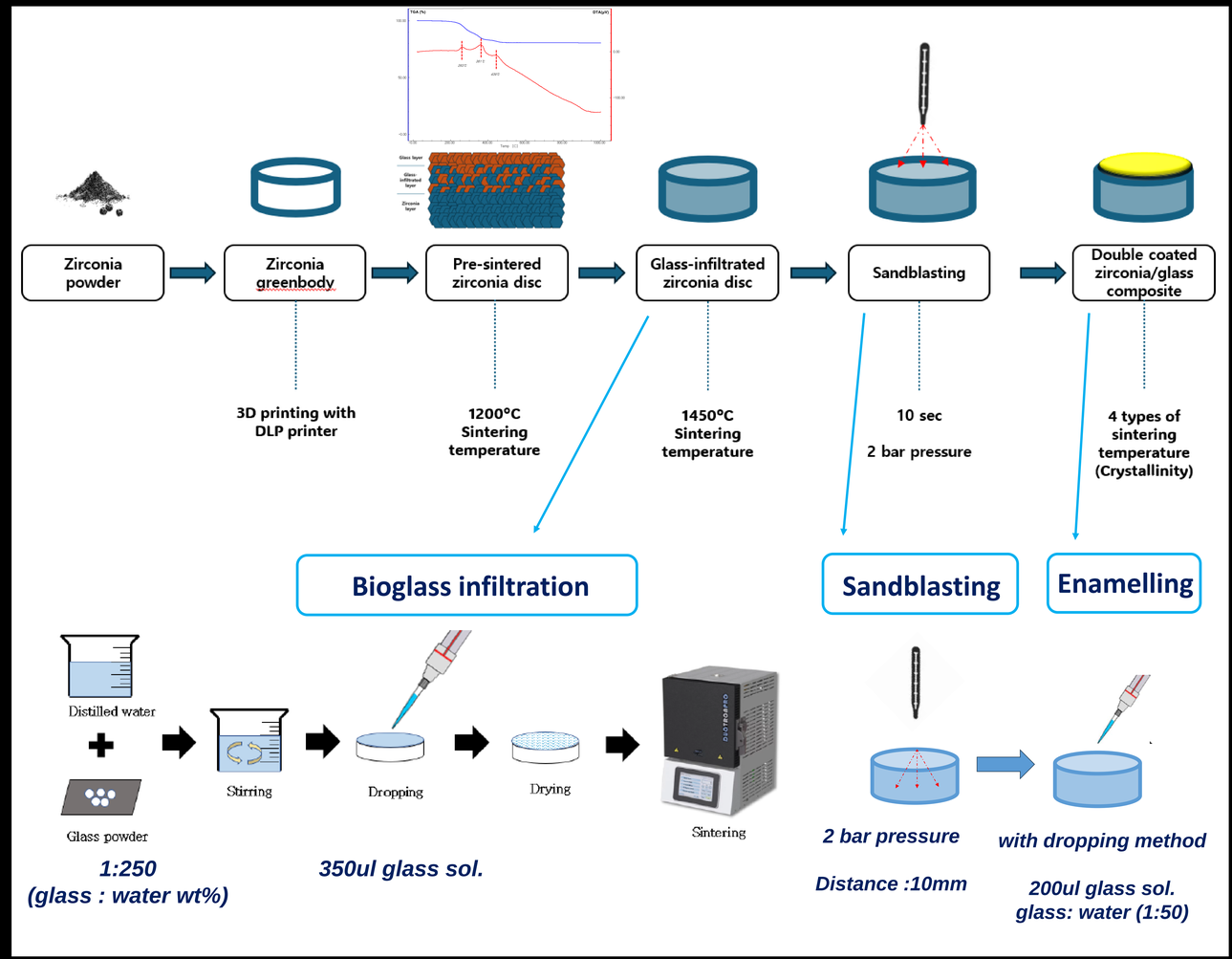
- ✓ Highest in vivo bioactivity index (IB>8) among all bioceramics.
- ✓ Astonishing biocompatibility and bone-bonding ability

45S5	SiO_2	Na_2O	CaO	P_2O_5
	45%	24.5%	24.5%	6%

AIM

- ➢ To manufacture zirconia composite using **3D printing** technology and to apply **dual coating on the zirconia** produced with 45S5® bioglass through **glass melting infiltration and enameling.**
- ➢ To evaluate the **mechanical, surface, and biological properties** of the coated zirconia to determine its suitability as a support structure for **bone tissue regeneration scaffolds.**

MATERIALS & METHOD



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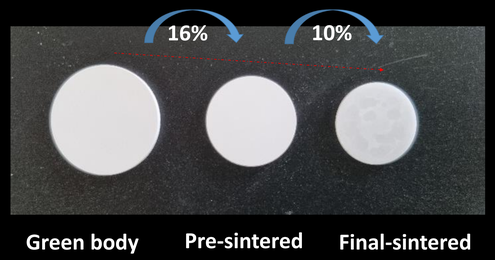
Group		Description
Z **(Control)**		Zirconia
ZG		Zirconia + glass infiltration
ZGC	ZGC-M	Zirconia + glass infiltration + enamelling *(Crystallinity = medium)*
	ZGC-H	Zirconia + glass infiltration + enamelling *(Crystallinity = high)*

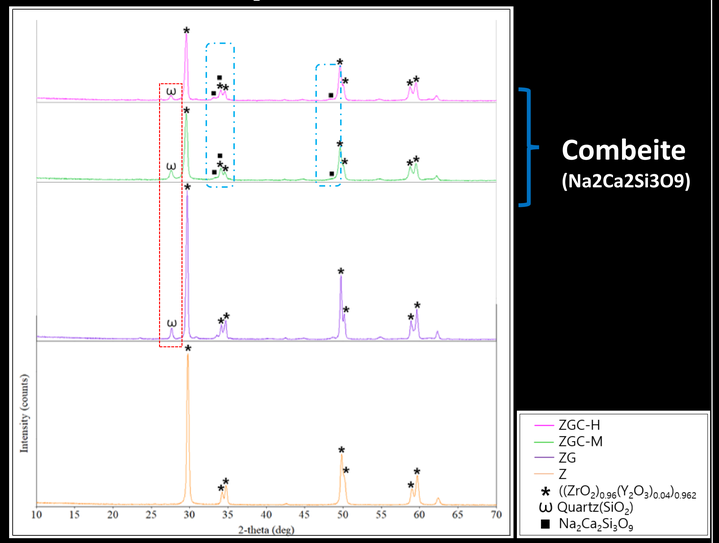
RESULTS

1-1. Fabrication of zirconia

Debinding & Sintering (Shrinkage approx. 26%)

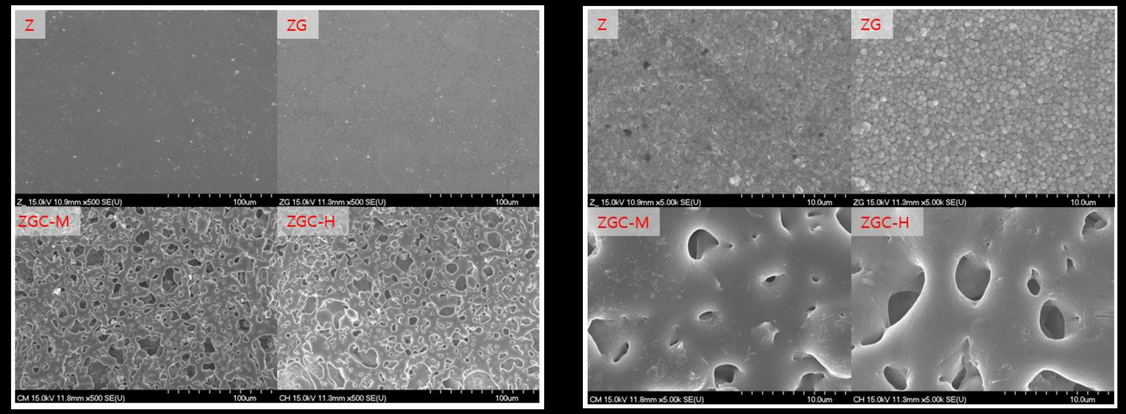


1-2. XRD analysis



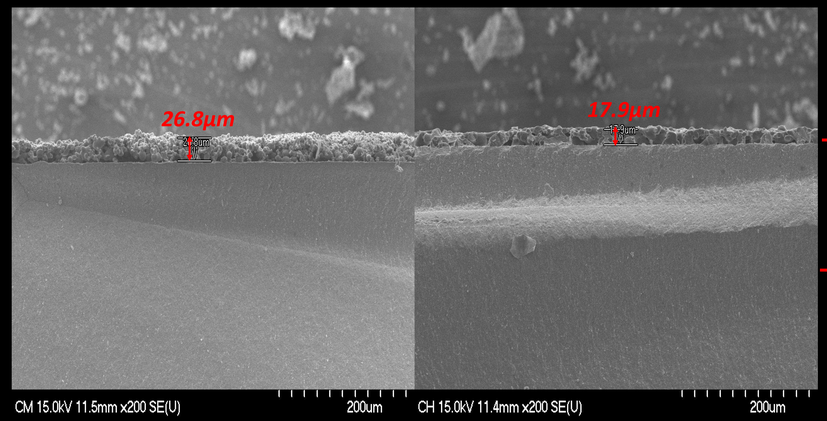
2. Surface characterization (SEM analysis)

x500 ***x5000***



Overall coating on the surface ***Coating layer without cracks***

Cross section



Coating layer

Zirconia layer

ZGC-M = 26.8μm ***ZGC-H = 17.9μm***

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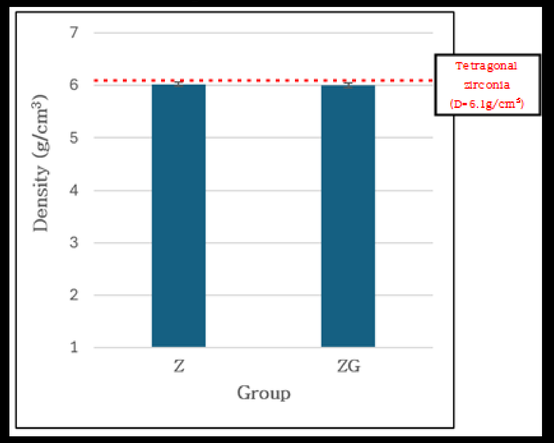
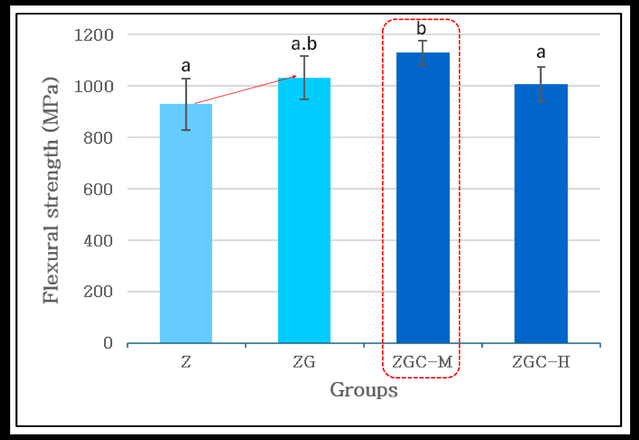
3. Mechanical characterization (SEM analysis)

3-1. Density



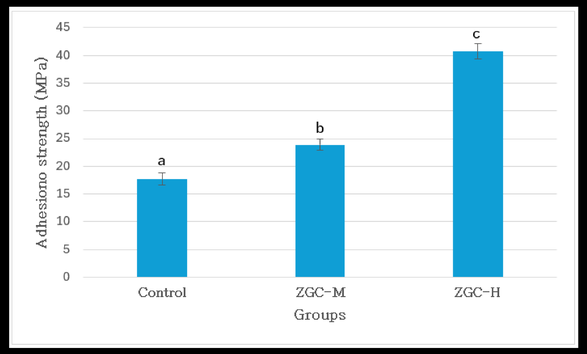
Before & after glass infiltration (n=10)

3-2. Biaxial flexural strength



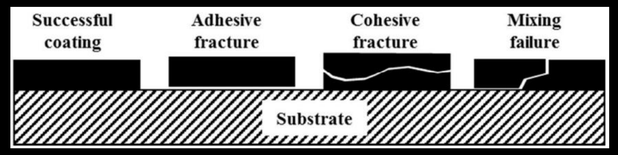
Difference letters represent significance ($p<0.05$)

3-3. Adhesion test



Short heat duration *Long heat duration*

Heat treatment above Glass transition temperature → Better inter-particle cohesion

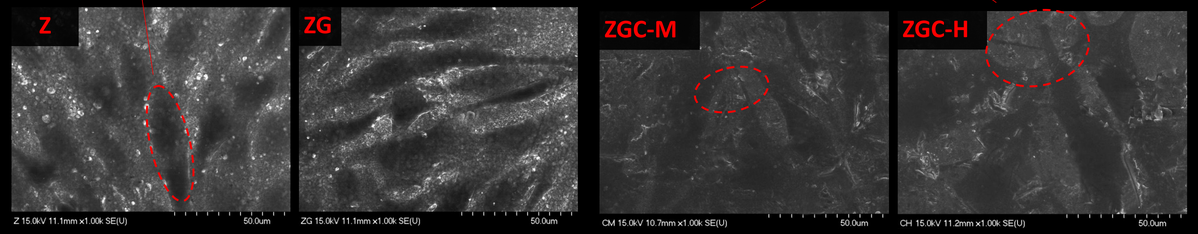


ZGC-M *ZGC-H* Control

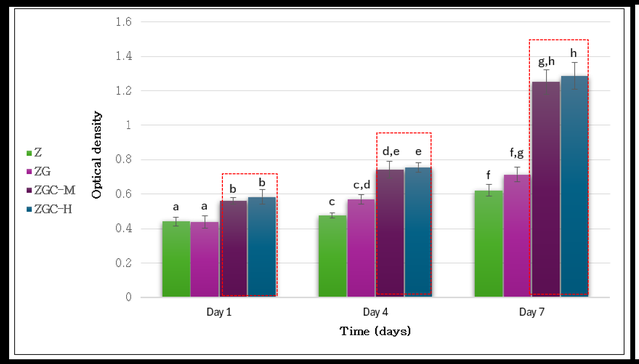
4. Biological characterization

4-1. Cell attachment

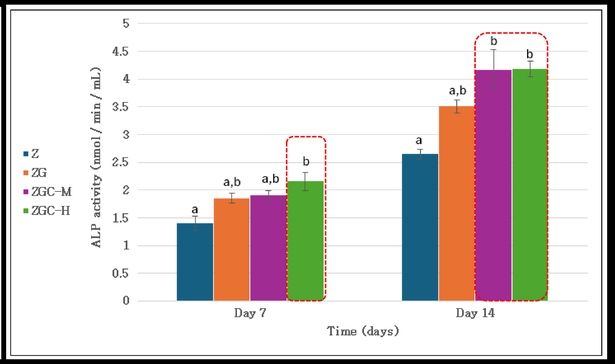
spindle-shaped *filopodia*



4-2. Cell proliferation



4-3. Cell differentiation



Conclusion

- ✓ The composite fabricated by double-coating 45S5 bioactive glass on 3D-printed zirconia exhibited **sufficient mechanical and biological properties** to be used as a bone regeneration scaffold.
- ✓ In particular, **the ZGC-H group** with the highest crystallization **showed the best adhesion strength and biological response**, and is thought to exhibit sufficient properties to be used as a bone regeneration scaffold in the future.