Incorporation of High Concentrations of Titanium in Bioactive Glasses for Bone Regeneration Application

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INTRODUCTION

- Bioactive glasses (BGs) react and dissolve when in contact with physiological fluid, producing **hydroxy carbonate apatite** (HCA) on its surface, that bonds to both bone and soft tissues(1)(2).
- Ti^{4+} incorporated into BG improves thermal properties and biocompatibility, but often **slows down HCA formation**, especially in high concentration (3).
- BGs can be made via sol-gel using a precursor like tetraethylorthosilicate (TEOS), and their reactivity can be optimized by changing the **TEOS to water ratio (R)** and the **catalyst** used.

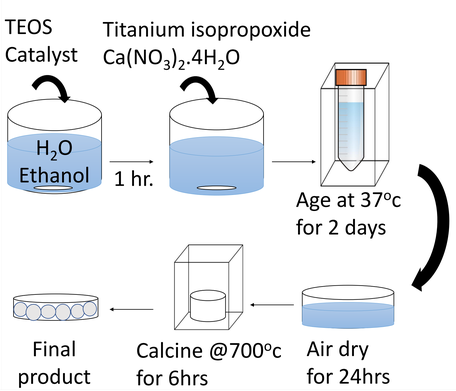
AIM

- To synthesize BGs containing a high concentration of titanium without slowing down HCA formation.

HYPOTHESIS

- We hypothesize that optimizing R, can improve the reactivity of BG with as high as 10%mol titanium concentration.

METHOD



RESULTS

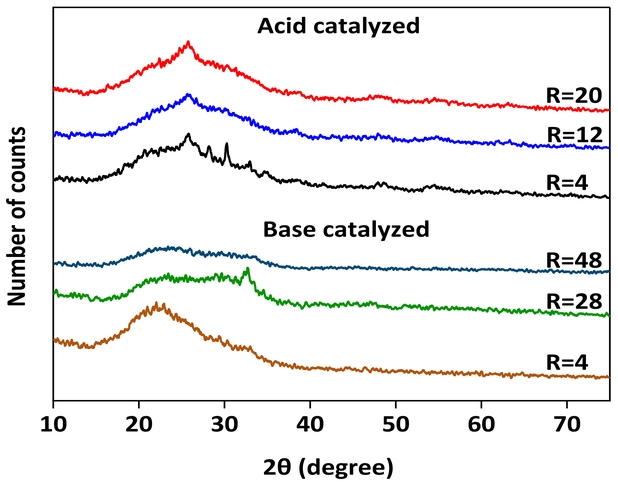


Fig. 1. XRD spectra showing changes in the structure of the glasses at different R values for acid (R=12 showed optimum changes with respect to crystallinity) and base catalyzed samples.

STRUCTURAL CHARACTERIZATION

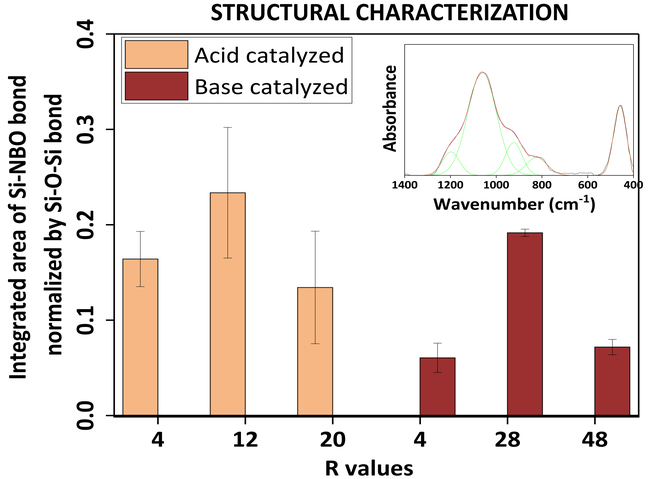


Fig. 2. Si-NBO bonds present for acid and based catalyzed samples at different R values, calculated from their corresponding IR spectra

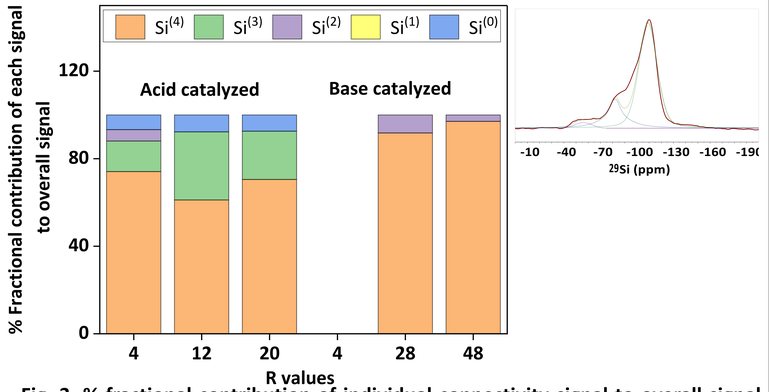


Fig. 3. % fractional contribution of individual connectivity signal to overall signal of NMR spectra, showing differences in the chemical environment of the silicon nuclei at different R values for acid and base catalyzed samples.

TEXTURAL CHARACTERIZATION

REACTIVITY TEST IN SIMULATED BODY FLUID (SBF)

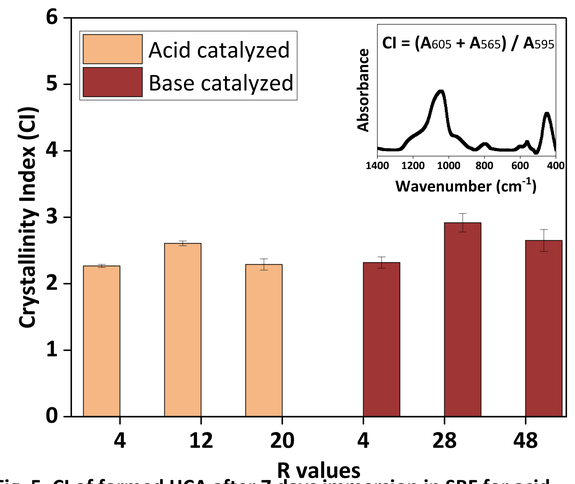


Fig. 5. CI of formed HCA after 7 days immersion in SBF for acid catalyzed (R=12 being the most reactive) and base catalyzed (R=28 being the most reactive) glass samples

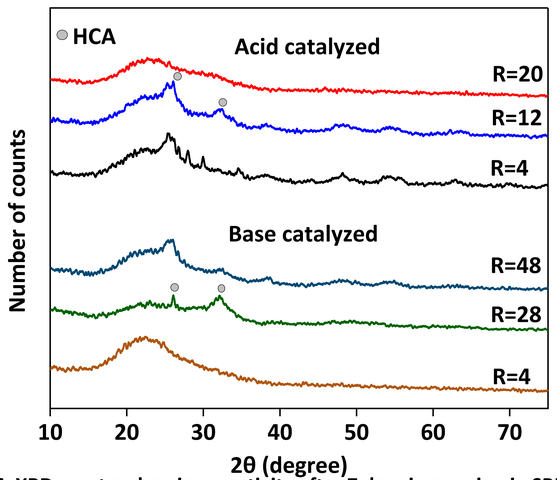


Fig. 6. XRD spectra showing reactivity after 7 days immersion in SBF for acid catalyzed (R=12 being the most reactive) and base catalyzed (R=28 being the most reactive) glass samples

CONCLUSION

- 10 mol% TiO_2 can be incorporated into BGs with fast HCA formation, by optimizing R values
- These TiO_2 BGs are expected to be able to improve bonding to bone and soft tissues.
- Future work would involve investigating the effect of our glass samples on protein adsorption and cellular activities.

ACKNOWLEDGEMENTS

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REFERENCES

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2. Hench, L.L., Materials in Medicine, 2006.
3. Smith, S., et al., Langmuir, 2021.