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Characterisation and Physico-Chemical Evaluation of a Novel Glass Ionomer Nanozirconia- Silica- Hydroxyapatite Hybrid Material

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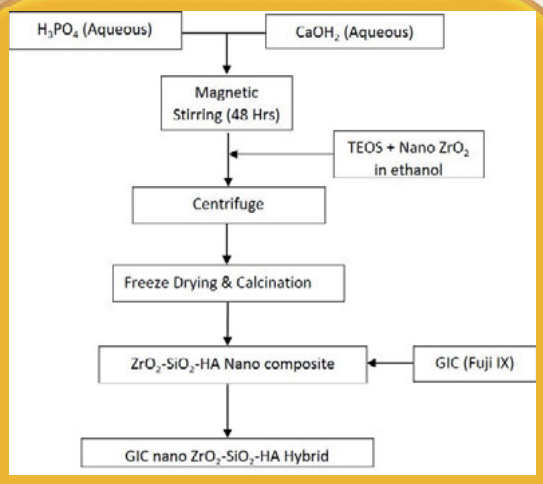
INDUTROCTION

- Glass ionomer cement (GIC) is among the popularly used materials in prosthodontics for core build- up and cementation of prostheses. However, GICs suffer from relatively inferior mechanical properties and sensitivity to initial desiccation. A novel GIC-nano Zirconia-Silica- Hydroxyapatite (GIC-nano ZrO_2-SiO_2-HA) has been developed which has better hardness and aesthetics (1-4).

OBJECTIVES

- To characterise and evaluate the colour stability and fluoride release of a new GIC-nano ZrO_2-SiO_2-HA hybrid material.

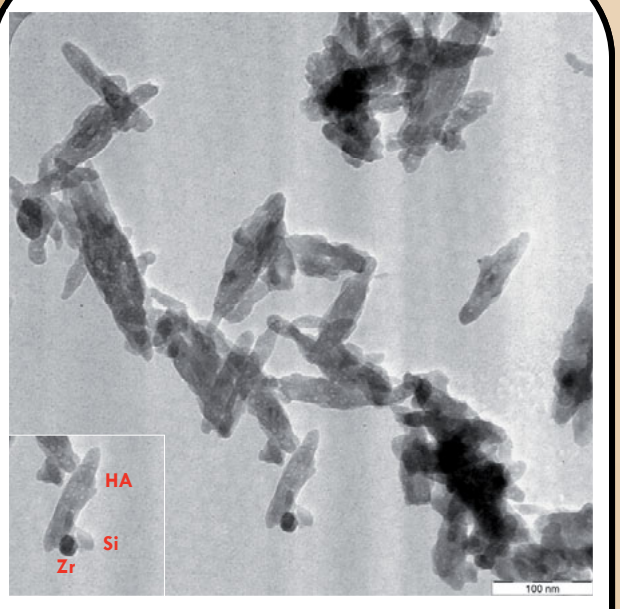
METHODOLOGY



- The nano ZrO_2-SiO_2-HA was synthesised using modified sol-gel technique (3), and the nanopowder was characterised using TEM, FTIR and XRD.
- The samples (n=10) per group were prepared by adding 5% by weight of nano ZrO_2-SiO_2-HA powder into conventional GIC (Fuji IX).
- The colour stability was measured (ΔE) with a spectrophotometer using the CIE L*a*b* system, and the fluoride (F^-) release was measured using an ISE meter over a one-month period.

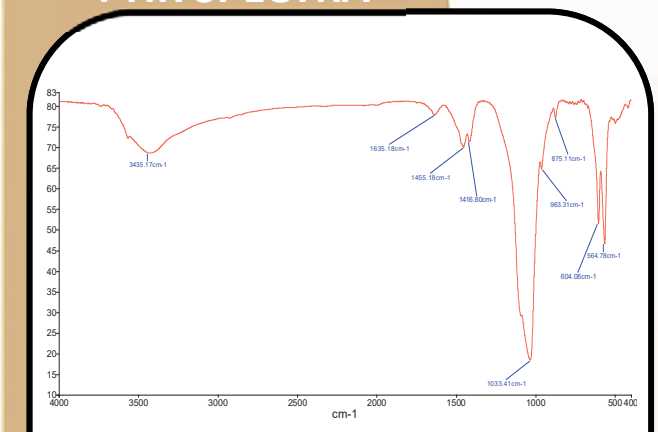
CHARACTERISATION

TEM MICROGRAPHS



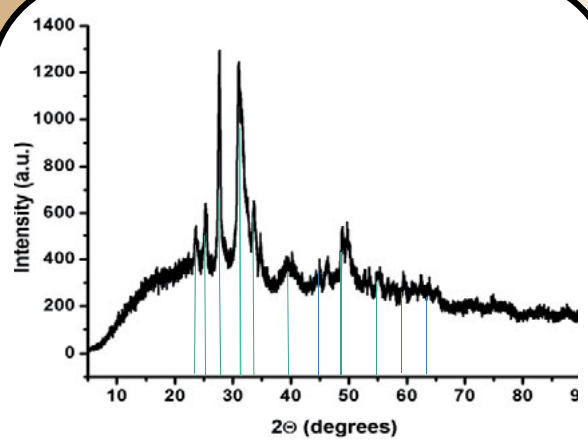
- TEM micrographs confirmed that all of the powder particles were in the nano scale range with the rod-shaped HA particles interspersed with spherical nano ZrO_2 and SiO_2(1,3).

FTIR SPECTRA



- Peak at 564.78- Refers to v_4 bending mode of PO_4^{3-} indicative of HA.
- 604.06- Assigned to O – Si – O and Zr –O – Zr bending and presence of HA.
- 875.11- Signifies HA with deficiency of Ca.
- 963.31- Certifies the structure of ZrO_2 .
- Therefore, it can be inferred that a homogenous nano ZrO_2-SiO_2-HA powder was successfully synthesised using sol-gel technique(3).

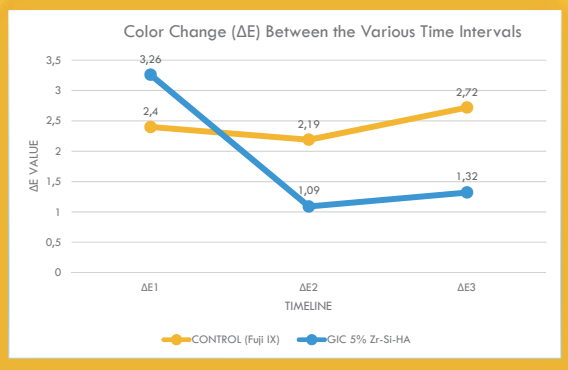
XRD DIFFRACTOGRAM



- ~23°- belongs to 120 plane of Sio_2
- ~25° and 28°- 002 and 102 plane of HA; 011 and 111 plane of Sio_2, respectively.
- ~32°and ~34°- 011 and 002 plane of ZrO_2, respectively.
- ~40°- 212 plane of HA.
- ~59 - 60°-121 plane of ZrO_2.
- These findings are in agreement with the results of FTIR spectroscopy.

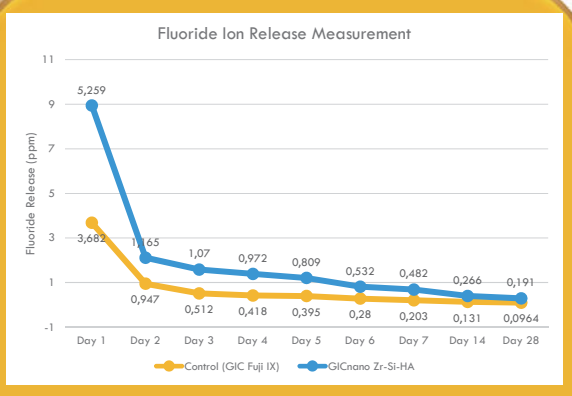
RESULTS

COLOUR STABILITY



- Repeated measures ANOVA shows a statistically significant difference between the day 1 to day 7 (ΔE_1) and day 14 to day 28 (ΔE_3) values for control (Fuji IX) and GIC 5% nano ZrO_2-SiO_2-HA. However, ΔE_2(1.09) and ΔE_3(1.32) for GIC 5% nano ZrO_2-SiO_2-HA were much lower compared to the control group (p≤0.05).

FLUORIDE RELEASE



- Both the control and GIC nano ZrO_2-SiO_2-HA showed similar patterns of F release during the course of the study. Repeated measures ANOVA reveals a highly significant difference (p≤0.05) in mean F release between both the groups for all the time intervals except for day 2, day 4 and day 28.

CONCLUSION

- The morphologic and qualitative characterisations of the nano ZrO_2-SiO_2-HA synthesised by a modified one-pot synthesis confirmed the presence of homogenously incorporated functional groups corresponding to each element.
- All the particles were in the nano-scale range, with spherical ZrO_2 and SiO_2 particles embedded in the voids between rod-shaped HA crystallites enhancing the packing density.
- The colour change between various time intervals shows that the ΔE values for GIC nanoZrO_2-SiO_2-HA were < 3.3 (i.e. acceptable) and generally were lower than those of the control group. Therefore, GIC nano Zr-Si-HA exhibited enhanced colour stability.
- It can be concluded that the addition of nano ZrO_2-SiO_2-HA to the GIC did not impede its F^- releasing ability. It in fact resulted in an overall higher F^- elusion from the GIC nanoZrO_2-SiO_2-HA when compared to the control group.

ACKNOWLEDGEMENT

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