

HYDROXYAPATITE REINFORCED GIC COMPOSITES FOR DENTAL IMPLANTS

Submitted in partial fulfillment of the requirements for the
award of Bachelor of Engineering degree in

MECHANICAL ENGINEERING

By

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**DEPARTMENT OF MECHANICAL ENGINEERING
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC 112B Status by UGC
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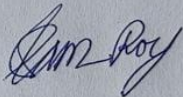
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DECLARATION

We **A.Sam Abeshek Roy (38150097)** and **A.Sivavijayan (38150110)** hereby declare that the Project Report entitled **Hydroxyapatite Reinforced Glass Ionomer Cement Composites for Dental Implants** done by us under the guidance of **Dr.R.B.Durairaj** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **A.Sam Abeshek Roy(38150097)** and **A.Sivavijayan (38150110)** who carried out the project entitled " **Hydroxyapatite Reinforced Glass ionomer cement Composites for Dental Implants** under my our supervision from November 2021 to May 2022.

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ABSTRACT

Glass Ionomer Cements (GICs) are one of the most important dental restorative materials. Improvement of biological and mechanical properties of these materials has been taken into consideration. The aim of this work was to preparation and characterization of GICs by adding Hydroxyapatite on compressive strength of GICs. In this research, Hydroxyapatite were added to GICs in different weight (0, 4 and 8 wt %). These samples were prepared in laboratory at room temperature and capsule dies were used for the preparation of the samples. We heated sample for 2 day at 100 C. All the samples were taken for Scanning Electron Microscope (SEM), Surface hardness and Pin On Disc Tribometer (Wear). The phase analysis of GICs composite was carried out by X-ray Diffraction (XRD) technique. In SEM image observed that pure GIC has more crack in inner region whereas in 4% HA GIC some crack and 8% HA GIC strongly bond. Results of the Surface hardness showed that adding HA with the values 8% tly weight had good compressive strength of GICs. The final result of this research was GICs containing Hydroxyapatite with improved equivalent mechanical properties. The improvement of GICs properties in

dentistry applications can be achieved by adding materials like Hydroxyapatite.

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LIST OF ABBREVIATIONS:

HA - Hydroxyapatite

GIC- Glass Ionomer Cements

SEM-Scanning Electron Microscope

XRD-X-Ray Diffraction

CHAPTER 1

INTRODUCTION

Glass Ionomer Cements (GICs) are of the most important tooth colored restorative accoutrements used in dentistry. Since the GICs were introduced to the dental profession by Wilson and Kent in 1972, the use of these accoutrements has been increased due to their exclusive parcels similar as proper biocompatibility with body's hard towel, long term fluoride release, the capability of absorbing and restoring fluoride, low thermal expansion measure, good adhesion to wettish enamel and dentin without challenging an intermediate agent and low cytotoxicity. Despite the below mentioned advantages, this group of substances has some disadvantages which substantially include low mechanical strength and perceptivity to moisture that limit their operations. Some sweats have been devoted to ameliorate the mechanical parcels of conventional GICs which include underpinning with essence maquillages, revision with resin. Objectification with SiC whiskers/ short filaments, HA and fluoroapatite nanobioceramics, forsterite nanoparticles,etc.

Hydroxyapatite (HA) is one of the most important calcium phosphate bioceramics ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$, chemical formula $\text{Ca}/\text{P} = 1.67$), and has a composition and clear structure analogous to apatite in the mortal dental structure and bone towel. In recent times, a number of studies have tried to assess the effect of HA addition to the restorative dental accoutrements similar as GICs. It was plant that glass ionomer cements were interacted with HA through the carboxylate groups in the polyacid. Hence, the objectification of HA into GIC greasepaint composition can't only ameliorate the biocompatibility of GICs, but also increase the mechanical parcels.

Delved the physical parcels of corroborated GIC modified with hydroxyapatite, an suggested that demineralization of enamel face could be averted by incorporating HA into GIC.

On the other hand, studies on ceramic patches (or glass globules) corroborated polymers suggested that the flyspeck size had goods on the mechanical parcels of mixes.

Thus the end of work is to conflation hydroxyapatite
To glass ionomer cement. To compare HA flyspeck size on
the mechanical parcels of GIC.

1.1.GIC (GLASS IONOMER CEMENT)

A glass ionomer cement (GIC) is a dental restorative material used in dentistry as a filling material and luting cement, including for orthodontic type attachment. Glass-ionomer cements are grounded on the response of silicate glass- greasepaint (calciumaluminofluorosilicate glass) and polyacrylic acid, an ionomer. Sometimes water is used rather of an acid, altering the parcels of the material and its uses. This response produces a powdered cement of glass patches girdled by matrix of fluoride rudiments and is known chemically as glass polyalkenoate. There are other forms of analogous responses which can take place, for illustration, when using an waterless result of tempera/ itaconic copolymer with tartaric acid, this results in a glass-ionomer in liquid form. An waterless result of maleic acid polymer or maleic/ tempera copolymer with tartaric acid can also be used to form a glass-ionomer in liquid form. Tartaric acid plays a significant part in controlling the

setting characteristics of the material. Glass-ionomer grounded composites incorporate another dental material, for illustration resin-modified glass ionomer cements (RMGIC) and compomers or modified mixes.

Non-destructive neutron scattering has substantiated GIC setting responses to be non-monotonic, with eventual fracture durability mandated by changing infinitesimal cohesion, shifting interfacial configurations and interfacial terahertz (THz) dynamics.

Glass ionomer cement is primarily used in the forestallment of dental caries. This dental material has good tenacious bond parcels to tooth structure allowing it to form a tight seal between the internal structures of the tooth and the girding terrain. Dental caries is caused by bacterial product of acid during their metabolic conduct. The acid produced from this metabolism results in the breakdown of tooth enamel and posterior inner structures of the tooth, if the complaint isn't interposed by a dental professional, or if the carious lesion doesn't arrest and/ or the enamel re-mineralises by itself. Glass ionomer cements act as sealants when recesses and crevices in the tooth do and release fluoride to help farther enamel demineralisation

and promote remineralisation. Fluoride can also hamper bacterial growth, by inhibiting their metabolism of ingested sugars in the diet. It does this by inhibiting colorful metabolic enzymes within the bacteria. This leads to a reduction in the acid produced during the bacteria's digestion of food, precluding a farther drop in pH and thus precluding caries.

The operation of glass ionomer sealants to occlusal shells of the posterior teeth, reduce dental caries in comparison to not using sealants at all. (requirements update) There's substantiation that when using sealants, only 6 of people develop tooth decay over a 2- time period, in comparison to 40 of people when not using a sealant. Still, it's recommended that the use of fluoride shield alongside glass ionomer sealants should be applied in practice to further reduce the threat of secondary dental caries.

1.1.1 Chemistry and setting reaction

All GICs contain a introductory glass and an acidic polymer liquid, which set by an acid- base response. The polymer is an ionomer, containing a small proportion – some 5 to 10 –

of substituted ionic groups. These allow it to be acid decomposable and clinically set readily.

The glass padding is generally a calcium aluminosilicate greasepaint, which upon response with a polyalkenoic acid gives a glass polyalkenoate- glass residue set in an ionised, Polycarboxylate matrix.

The acid base setting response begins with the mixing of the factors. The first phase of the response involves dissolution. The acid begins to attack the face of the glass patches, as well as the continuous tooth substrate, therefore pouring their external layers but also neutralising itself. As the pH of the waterless result rises, the polyacrylic acid begins to ionise, and getting negatively charged it sets up a proximity grade and helps draw cations out of the glass and dentine. The alkalinity also induces the polymers to disconnect, adding the density of the waterless result.

The alternate phase is gelation, where as the pH continues to rise and the attention of the ions in result to increase, a critical point is reached and undoable polyacrylates begin to precipitate. These polyanions have carboxylate groups

whereby cations bind them, especially Ca^{2+} in this early phase, as it's the most readily available ion, crosslinking into calcium polyacrylate chains that begin to form a gel matrix, performing in the original hard set, within five twinkles. Crosslinking, H bonds and physical trap of the chains are responsible for gelation. During this phase, the GIC is still vulnerable and must be defended from moisture. However, the chains will degrade and the GIC lose its strength and optic parcels, If impurity occurs. Again, dehumidification beforehand on will crack the cement and make the face pervious.

Over the coming twenty four hours development occurs. The less stable calcium polyacrylate chains are precipitously replaced by aluminium polyacrylate, allowing the calcium to join the fluoride and phosphate and verbose into the tooth substrate, forming polysalts, which precipitously hydrate to yield a physically stronger matrix.

The objectification of fluoride detainments the response, adding the working time. Other factors are the temperature of the cement, and the greasepaint to liquid rate – further greasepaint or toast speeding up the response.

GICs have good tenacious relations with tooth substrates, uniquely chemically relating to dentine and, to a lower extend, to enamel. During original dissolution, both the glass patches and the hydroxyapatite structure are affected, and therefore as the acid is softened the matrix reforms, chemically welded together at the interface into a calcium phosphate polyalkenoate bond. In addition, the polymer chains are incorporated into both, weaving cross links, and in dentine the collagen fibres also contribute, both linking physically and H- relating to the GIC swab precipitates. There's also microretention from porosities being in the hydroxyapatite.

1.1.2 Advantages

- ❖ Requires minimum junking of healthy tooth structure
- ❖ Ease of placement
- ❖ Versatility of use
- ❖ Bonds exceptionally well to tooth face without the need for a relating agent
- ❖ Hardens incontinently by light curing
- ❖ Releases fluoride over time

1.1.3 Disadvantages

- ❖ Fairly low continuity-further prone to fracture and wear than mixes
- ❖ Lower tensile strength than mixes Limited shade to mixes ranges in comparison

1.2.HYDROXYAPATITE

Hydroxyapatite, also called hydroxylapatite (HA), is a naturally being mineral form of calcium apatite with the formula $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$, but it's generally written $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ to denote that the demitasse unit cell comprises two entities. Hydroxyapatite is the hydroxyl endmember of the complex apatite group. The OH⁻ ion can be replaced by fluoride, chloride or carbonate, producing fluorapatite or chlorapatite. It crystallizes in the hexagonal demitasse system. Pure hydroxyapatite greasepaint is white. Naturally being apatites can, still, also have brown, unheroic, or green colors, similar to the contusions of dental fluorosis.

Up to 50 by volume and 70 by weight of mortal bone is a modified form of hydroxyapatite, known as bone mineral.

Carbonated calcium-deficient hydroxyapatite is the main mineral of which dental enamel and dentin are composed. Hydroxyapatite chargers are also plant in the small calcifications, within the pineal gland and other structures, known as corpora arenacea or" brain beach.

1.2.1 Chemical synthesis

Hydroxyapatite can be synthesized via several styles, similar as wet chemical deposit, biomimetic deposit, sol-gel route (wet-chemical rush) or electrodeposition. The hydroxyapatite nanocrystal suspense can be prepared by a wet chemical rush response following the response equation below.



The capability to synthetically replicate hydroxyapatite has inestimable clinical counteraccusations, especially in dentistry. Each fashion yields hydroxyapatite chargers of varied characteristics, similar as size andshape. These variations have a pronounced effect on the natural and

mechanical parcels of the emulsion, and thus these hydroxyapatite products have different clinical uses.

1.2.2 Properties

- ❖ The capability to integrate in bone structures and support bone ingrowth, without breaking down or dissolving (i.e it's bioactive).
- ❖ Hydroxyapatite is a thermally unstable emulsion, putrefying at temperature from about 800-1200 °C depending on its stoichiometry.
- ❖ Generally speaking thick hydroxyapatite doesn't have the mechanical strength to enable it to succeed in long term cargo bearing operations.

1.2.3 Applications

Coatings of hydroxyapatite are frequently applied to metallic implants (most generally titanium/ titanium blends and pristine brands) to alter the face parcels. In this manner the body sees hydroxyapatite- type material which it's happy to accept. Without the sheeting the body would see a foreign body and work in such a way as to insulate it from girding apkins. To date, the only commercially

accepted system of applying hydroxyapatite coatings to metallic implants is tube spraying.

Hydroxyapatite may be employed in forms similar as maquillages, pervious blocks or globules to fill bone blights or voids. These may arise when large sections of bone have had to be removed (e.g. bone cancers) or when bone accruals are needed (e.g maxillofacial reconstructions or dental operations). The bone padding will give a altar and encourage the rapid-fire stuffing of the void by naturally forming bone and provides an volition to bone grafts. It'll also come part of the bone structure and will reduce mending times compared to the situation, if no bone padding was used.

CHAPTER 2

LITERATURE SURVEY

Moshaverinia A, Ansari S, Moshaverinia M, Roohpour N, Darr JA, Rehman 2008 Hydroxyapatite (HA) has excellent natural gesture, and its composition and clear structure are analogous to the apatite in the mortal dental structure and cadaverous system; a number of experimenters have tried to estimate the effect of the addition of HA maquillages to restorative dental accoutrements. In this study, nanohydroxy and fluoroapatite were synthesized using an ethanol grounded sol-gel fashion. The synthesized nanoceramic patches were incorporated into marketable glass ionomer greasepaint (Fuji II GC) and were characterized using Fourier transfigure infrared and Raman spectroscopy, X-ray diffraction and surveying electron microscopy. Compressive, diametral tensile and biaxial flexural strengths of the modified glass ionomer cements were estimated. The effect of nanohydroxyapatite and fluoroapatite on the bond strength of glass ionomer cement to dentin was also delved.

Goenka S, Balu R, Kumar TSS.2012 Glass ionomer cements (GICs) are clinically seductive stuffing accoutrements frequently employed in the field of dentistry as restorative and luting accoutrements. The present work aims to formulate bioactive nanocrystalline calcium deficient hydroxyapatite (nCDHA)-GIC compound cements with bettered mechanical and resorption parcels of the set cement than GICs. The nCDHA was synthesized via an accelerated fryer process and characterized by X-ray greasepaint diffraction (XRD) and Fourier transfigure infrared spectroscopy (FT-IR) styles. The synthesized nCDHA was mixed with GIC in different compositions (6, 10 and 15 wt) maintaining the greasepaint to liquid rate. Cylinders of confines 8 mm height and 4 mm periphery were formed using a Teflon earth following a conventional cement forming fashion.

Arita K, Yamamoto A, Shinonaga Y, Harada K, Abe Y, Nakagawa K, et 2011 to ameliorate the mechanical and chemical parcels of conventional restorative glass ionomer cement (GIC) by adding hydroxyapatite (HAp) medications with different characteristics, and to probe the beginning

response mechanisms. Fuji IX GP was used as the control GIC. The experimental GICS comported of four HAP patches with different characteristics added at 8 mass to Fuji IX- greasepaint. All cements were prepared by mixing with Fuji IX-liquid. Four HAp- patches were anatomized, and also the mechanical strengths and the fluoride-ion-release- recharge- actions of five GIC groups were estimated. The results of this study demonstrate that the addition of HAP patches with largely reactive parcels similar as high specific face area can enhance the flexural strength and fluoride ion release parcels of conventional restorative GIC. Our results further indicate that HAp functions as an adsorbent and an ion interchangeable agent, performing in bettered mechanical and chemical parcels of GIC.

Moshaverinia A, Roohpour N, Chee WWL, SchrickerSR.2011. Glass-ionome cements have numerous parcels that are clinically useful and promote life. Importantly, GICS cleave to wettish tooth structure without any pretreatment, and give a prolonged period of fluoride release, which inhibits intermittent tooth decay (caries). These parcels together with respectable aesthetics and

biocompatibility make these accoutrements popular and desirable for medical and dental operations. Still, glass-ionomer dental cements have limitations that help broader clinical adaption similar as poor mechanical parcels and humidity perceptivity. Numerous significant changes and variations to the chemistry of the acidic polymers and introductory spectacles and to the expression of the cements have been made to address these limitations. In this review, advances in the development of the introductory spectacles and other buttressing agents will be bandied. An overview of the chemistry of glass-ionomer cements will be bandied followed by an in- depth discussion of the chemistry of new introductory spectacles and buttressing complements.

CHAPTER 3

AIM AND SCOPE OF PRESENT INVESTIGATION

3.1. AIM

The Experiment on Characterization of Reinforcement of Hydroxyapatite with Glass Ionomer Cement Composites.

3.2.SCOPE OF THE STUDY

- ❖ This study titled on “Reinforcement of Hydroxyapatite with Glass Ionomer Cement Composites” which help in strength the GIC for dental materials
- ❖ This study cover all the aspects of dental materials and helps in gain knowledge.

CHAPTER 4

EXPERIMENTAL AND METHODS

4.1.PREPARATION OF GIC COMPOSITES

Commercially available Glass ionomer cement(PYRAX GIC Type 2 Restorative)were purchased from chennai market.

Shake the talc bottle well every time before use. Apportion 2g of talc (Calcium-alumina-fluorosilicate glass) and 1.2 g of liquid (Polyacrylic acid) on to the mixing plate. Use plastic spatula to divide the talc into 2 equal portions and mix the first portion with all of the fluid for 10 seconds. . Mix the remaining portion with the paste formed for 20 secs. The total blend time should be 30 secs. Transfer cement to the set tooth face using suitable placement instrument and finish the restoration. Allow 8-10 mins for proper setting.

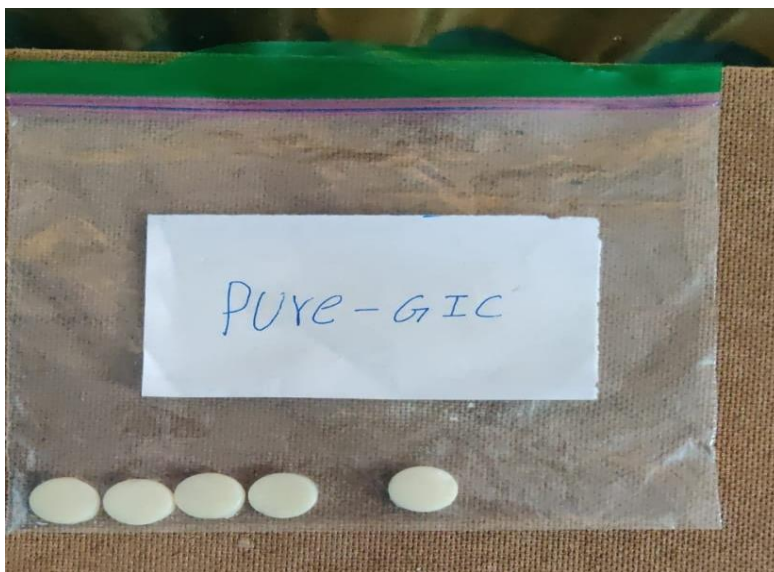


Fig : 4.1 : Pure GIC sample

4.2 PREPARATION OF GIC+4%HA

Shake the talc bottle well every time before use. Apportion 2g of talc (Calcium-alumina-fluorosilicate glass), 1.2g of liquid (Polyacrylic acid) and 4 % Hydroxyapatite on to the mixing plate. Use plastic spatula to divide the greasepaint into 2 equal corridor and mix the first portion with all of the liquid for 10 seconds. Mix the remaining portion with the paste formed for 20 secs. The total blend time should be

30 secs. Transfer cement to the set tooth face using suitable placement instrument and finish the restoration. Allow 8-10 mins for proper setting.

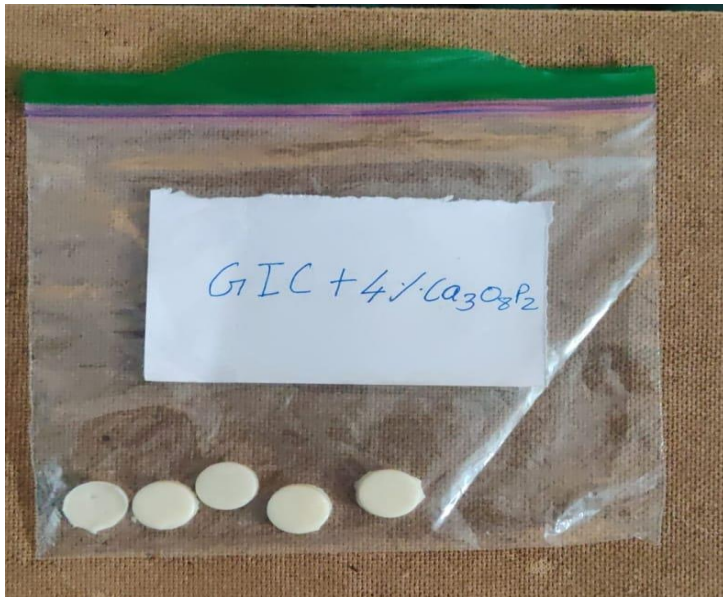


Fig : 4.2 : 4%HA+GIC sample

4.3 PREPARATION OF GIC+8%HA

Shake the talc bottle well every time before use. Apportion 2g of talc (Calcium-alumina-fluorosilicate glass), 1.2 g of liquid (Polyacrylic acid) and 4 % Hydroxyapatite on to the

mixing plate. Use plastic spatula to divide the talc into 2 equal portions and mix the first portion with all of the liquid for 10 seconds. Mix the remaining portion with the paste formed for 20 secs. The total blend time should be 30 secs. Transfer cement to the set tooth face using suitable placement instrument and finish the restoration. Allow 8-10 mins for proper setting.

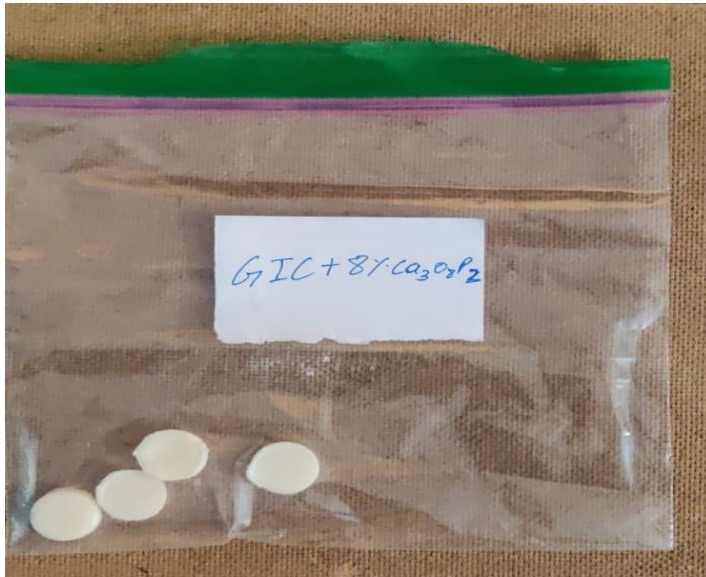


Fig : 4.3 : 8%HA+GIC sample

4.4 SETTING TIME

All the prepared samples were taken for setting time at room temperature of $34\pm1^{\circ}\text{C}$. The recorded setting time were listed in the table.

Table 4.1 : Setting time

SL.NO	SAMPLE	SETTINGTIME (s)
1	PURE GIC	223
2	GIC+4%HA	261
3	GIC+8%HA	311

4.5 HEAT TREATMENT

All samples are kept in direct sunlight for 3days.Due to present of moisture content, We heated the samples at 100°C for 4hrs in vaccum oven to remove moisture content in it. The heat treatment done at International research center of sathyabama institute of science and Technology, Chennai.



Fig : 4.4 : Heat treatment

4.6 SEM

The samples were tested in Carl ZEISS AG Brand Scanning electron Microscope made in Germany was available at VB'S Ceramic Research Center, Chennai and The samples were coated with Gold Sputtering before testing.

4.7 XRD

X-ray Diffraction (XRD) techniq (Philips X'Pert-MPD system with a Cu Ka, 1.5418 Å) was used to analyze the

structure of the prepared glass ionomer powder and the GIC-HA composites. The diffractometer was operated at 40 kV and 30mA at a 2 θ range of 10-90° employing a step size of 5s per step. The samples were cutted in the size of 20mm diameter and 1mm thickness.

4.8 PIN ON DISC

The samples were tested in W.C.DUCOMB machine and the machine has maximum speed of 2000 rpm and the average Newton is around 5N-50N.

4.9 SURFACE HARDNESS

The surface hardness were done using Vickers Hard Wilson Wolpert Germany make testing machine. We produced three samples Pure GIC, 4%HA+GIC, 8%HA+GIC. The results were recorded and plotted with samples and hardness number.

4.9.1 Specifications

Test loads :5 kgf

Magnification of optical measuring device: 70 x (140x-optional)

Maximum test height: 230 mm

Scale least count mm: 0.001 mm

Throat depth: 135 mm

Machine dimension: 460 x 225 x 860 mm

Weight: 70kgf

Dwell time: 0.30 ± 2 Sec. adjustable

CHAPTER 5

RESULTS AND DISCUSSION

5.1. SCANNING ELECTRON MICROSCOPY (SEM)

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by surveying the face with a focused ray of electrons. The electrons interact with features in the sample, producing colorful signals that contain information about the face geomorphology and composition of the sample. The electron ray is scrutinized in a raster checkup pattern, and the position of the ray is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, secondary electrons emitted by features excited by the electron ray are detected using a secondary electron sensor (Everhart Thornley sensor). The number of secondary electrons that can be detected, and therefore the signal intensity, depends, among other effects, on instance geomorphology. Some SEMs can achieve judgments better than 1 nanometer.

The scanning electron microscopic images were shown in Fig. Whereas the Fig: 5.1 GIC SEM image as so many crack in the sample. In Fig: 5.2 4%HA+GIC bonded well and as crack in it. Finally in Fig: 5.3 8%HA+GIC were strongly bonded and have less crack.

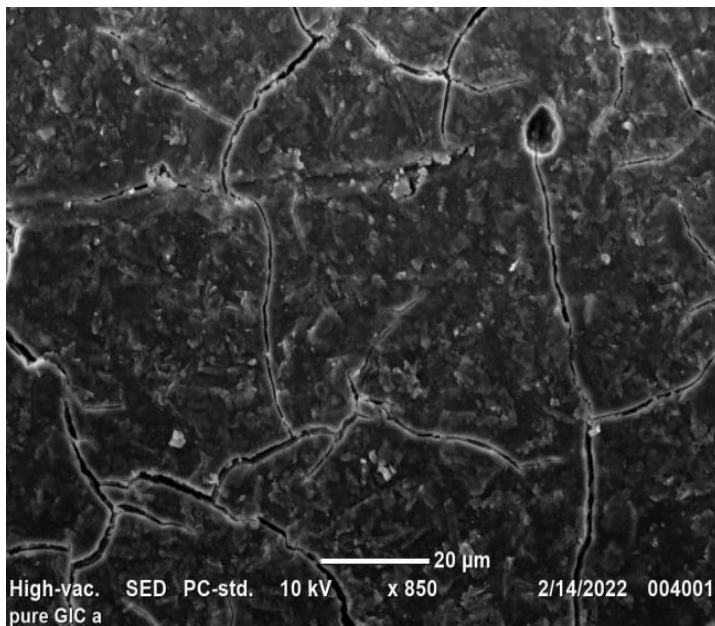


Fig: 5.1 : Pure GIC

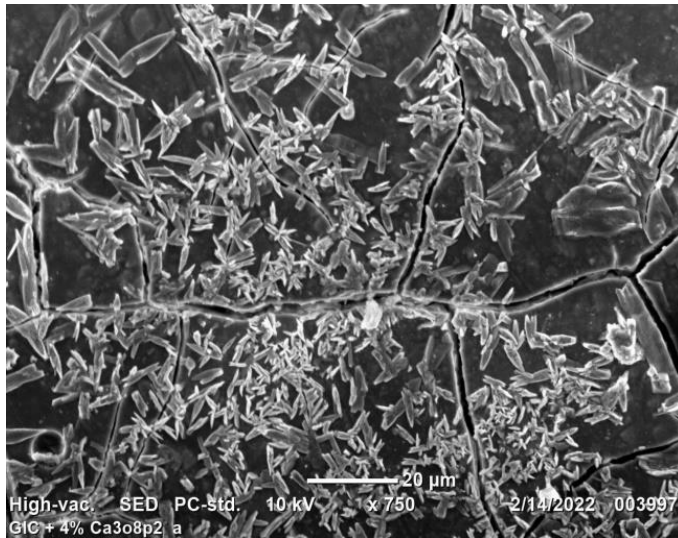


Fig : 5.2: 4%HA+GIC

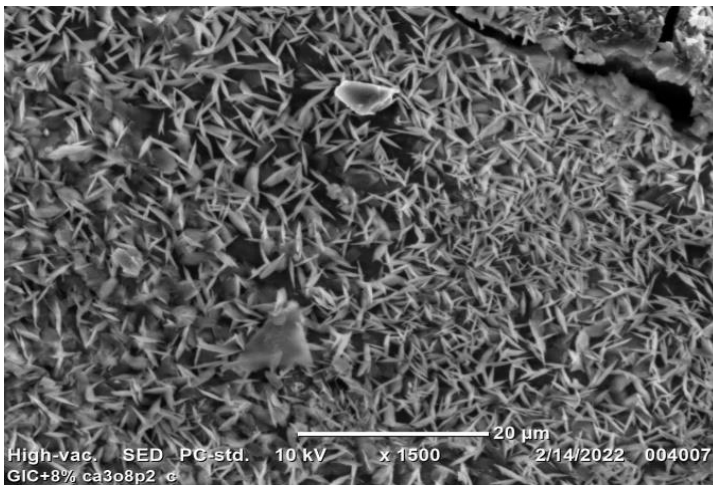


Fig : 5.3: 8%HA+GIC

5.2 X-RAY DIFFRACTION (XRD)

X-ray diffraction, or XRD, is a approach for analysing the infinitesimal or molecular structure of accoutrements. It'snon-destructive, and works most effectively with accoutrements that are wholly, or part,crystalline.The fashion is frequently known asx-ray talu diffraction because the material being analysed generally is a finely base down to a invariant state.

Diffraction is when light bends slightly as it passes around the edge of an object or encounters an obstacle oraperture.The degree to which it occurs depends on the relative size of a wavelength compared to the confines of the orifice it encounters.

X-ray Diffraction (XRD) techniq (Philips X'Pert-MPD system with a Cu Ka, 1.5418 Å) was used to analyze the structure of the prepared glass ionomer powder and the GIC-HA composites. The diffractometer was operated at 40 kV and 30mA at a 2θ range of 10-90° employing a step size of 5s per step.

The XRD patterns of GIC powder, 4%HA+GIC and 8%HA+GIC are shown in Figure . The pattern of GIC & 4%HA+GIC (Figure 5.4&5) did not contain diffraction peaks, indicated the internal disorder and the glassy nature of this material.

In addition, the XRD patterns 8%HA+GIC showed the peaks related to HA particles in glass ionomer structure (Figure 5.6). These results had a good agreement with the results reported by Kotteshwaran(VB'S Ceramic Research Center Chennai).

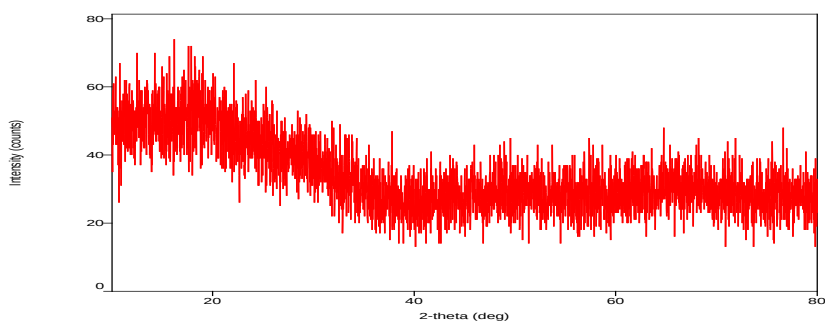


Fig: 5.4 : Pure GIC

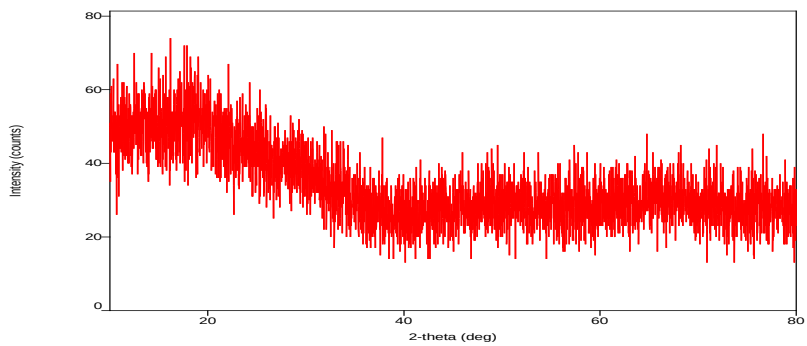


Fig: 5.5 : 4%HA+GIC

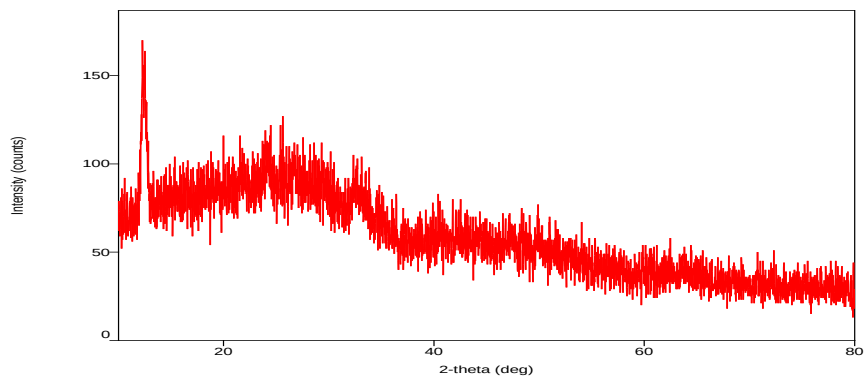


Fig : 5.6 : 8%HA+GIC

5.3 PIN ON DISC

Friction and wear (typically wear rates and wear resistance) characterization of materials is typically performed using various types of tribometer, while pin on disk test being probably one of the most common. The popularity of the system is due to its relative simplicity and cornucopia of the tribological connections that can be well described by the a simple pin on disk motion from dry connections of bolt screws to rail wheels to rail contact and to oiled contact of natural implants. The test commonly allows to test several move modes, similar as unidirectional, fretting modes and newly any other complex move patterns.

Pin On Disc the applied load 50N and disc speed range of 1000 rpm.sample thickness is 30mm. These results had a good agreement with the results reported by Kotteshwaran(VB'S Ceramic Research Center Chennai).

Pin On Disc Tribometer results were plotted.At the beginning, it increases up to a peak value and then decreases. Consecutively, it starts adding again up to a second peak, and also precipitously decreases down to the

steady- state value. The increase in attention of HA is acting as a protective subcaste of the dentin and reduces the wear rate. In continuation with the reduced concentration of HA the percentage of reinforcement with GIC is poor and increasing linearly with the rate of wear.

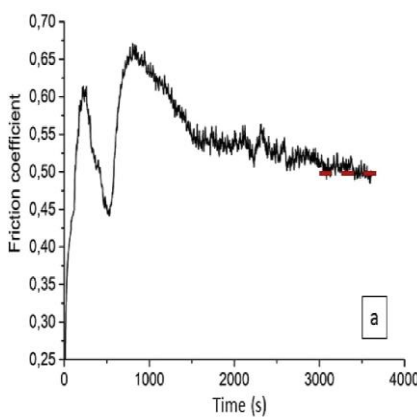


Fig : 5.7 : 4%HA+GIC

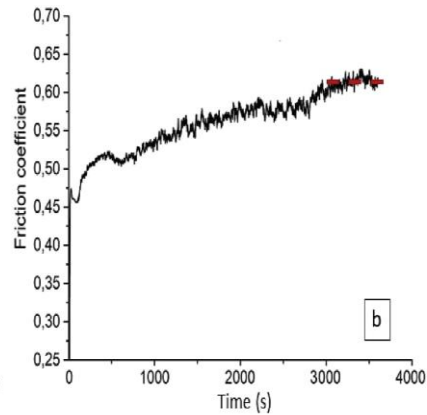


Fig: 5. : 8%HA+GIC

5.4 SURFACE HARDNESS

The Vickers hardness test is a test performed to measure the hardness of accoutrements, specifically thin sections and small parts. It's comprised of a diamond indenter and a light cargo to produce an indentation on the subject under testing. The depth of indentation is transfrom into the hardness value of the object.

The lesser the indentation, the harder the object. Likewise, if the cavity is large, the material is lacking in hardness. This test is applied by multiplex industriousness to determine the right type of material to use for operations and instrument. A material with ideal hardness according to its purpose should be chosen.

The Vickers hardness test is also known as microhardness testing.



Fig : 5.9 : Vickers hardness test

The surface hardness results were plotted for three trials with the recorded values. The results were shown in graph. It is observed that the surface hardness results of pure GIC ranges from (79.5-81.2), where 4% HA reinforced GIC shows the surface hardness of (30.2-38.7).

In another hand 8% reinforcement of HA with GIC shows greater improvement of surface hardness (53.5-66.5). This is due to the impact of reinforcement in higher concentration with the GIC.

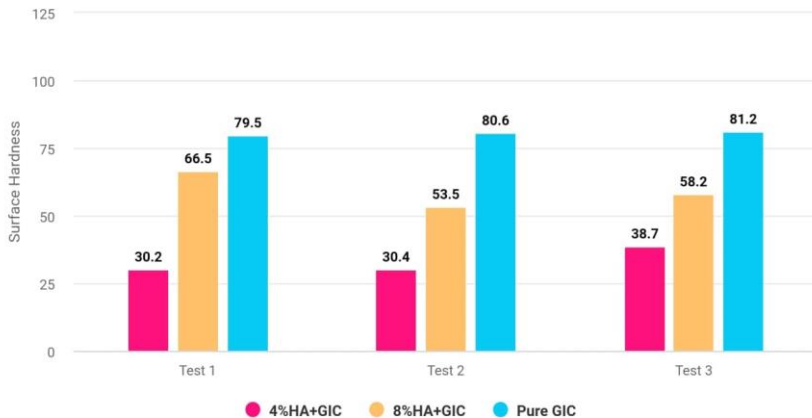


Fig : 5.10 : Surface hardness

CHAPTER 6

CONCLUSIONS AND SUMMARY

The experimentation on Reinforcement of Hydroxyapatite with Conventional Glass ionomer cement were performed. The following conclusions were made with this work. For 4% addition of Hydroxyapatite reinforcement with glass ionomer cement will not have greater effect in obtaining quantitative improvements on the glass ionomer. This may reduce the rate of wear nearly about 30 to 45% during the Pin On Disc (wear) examination, but it is found the surface hardness values were very low when compare to pure Glass ionomer. For 8% addition of Hydroxyapatite to glass ionomer has some good improvements in terms of wear resistance, surface hardness results (64 Hv) which is greater than the 4% addition of Hydroxyapatite . These substrates also found less cracks and very strong bonding with the glass ionomer.

However, Setting time & Heating has greater impact with the material properties. Factors like environmental conditions, mixing time, proportion of resin may influence directly in the mechanical properties of the materials.

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