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RESEARCH ARTICLE

INFLUENCE OF ZINC OXIDE ON SELF CURE DENTURE BASE RESINS

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Abstract

The self cure denture base resins are used in dentistry for various applications of the dentulous and edentulous patients. It suffers from many disadvantages like porosity , tear strength , thermal stability, and hardness etc. We have intercalated nanometric zinc oxide particles to minimize the defect to little extent. The objective of our study is to evaluate the performance by Scanning Electron Microscopy (SEM), Fourier Transform Infrared spectroscopy (FT-IR) , Chemical Stability, Thermo Gravimetric Analysis,(TGA) and Hardness studies. These results showed improvement in their properties.

INTRODUCTION

Denture base resins is tinted in dentistry to imitate the natural gum tissues in dentistry. Heat cure and self cure denture base resins are two types which are used for the preparation of artificial teeth and denture work. Poly (methyl methacrylate) is one of the major ingredient in both types of the resins. Dentures prepared from self cure denture base resins suffers many draw backs like porosity , chemical stability, tear resistance , hardness compared to heat cured resins (Ralph W. Phillip,1982). Acrylic resin dentures are notable for their tendency to absorb water which causes corresponding dimensional changes and hydrolytic degradation of polymers.(Cheng ,YY et.al 1993: Wong ,DM et al . 1999). The influence of various metal oxides on mechanical and physical properties of heat cured denture base resins were studied. (Neset volkan Asar et.al 2013) Zinc oxide nanostructures have attracted much attention because of their novel applications in diverse fields .(Hao Li.,et al 2005) . Transition metal complexes induced polymers either attach to or directly inserted in a pi- conjugated back bone are an exciting and a promising class of modern materials(Birendra et al 2013).

In the present investigation , we have introduced nanoparticles of ZnO, to the self cure denture base resins . The objective of our study is to analyze the various micro structural ,physical ,chemical and mechanical changes in a polymer network of self cure denture base resins on addition of Zinc oxide as a filler.

2.MATERIALS AND METHODS

2.1 Synthesis of Nanocomposites of denture base resins(NDBR)

In our study of in situ polymerization technique(Shahzada. A.et.al 2007) Liquid containing monomer methyl methacrylate (MMA) and polymer powder containing Poly (methyl methacrylate)(PMMA) of self cure denture base resins were mixed in the ratio 1:3 by volume were placed in a porcelain jar. It was allowed to 3-5 minutes for curing along with 0.1 gm of nanometric Zinc oxide dissolved in 0.1 M hydrochloric acid. The samples of 2 X 2 X 0.5 cm and 9 X 1 X 0.5 cm dimensions were prepared by pouring the putty consistency of the polymer in to moulds using Denture Base Resin (DBR) and Nanocomposites of Denture base resin with ZnO(NDBR) and characterized by the following techniques(Fig 1). ZnO nano particles were prepared from Zinc (II) acetate by previous methods.(Anzlovar. A. et. al 2011)and 1 % by weight of ZnO was used for all the studies due to agglomeration in higher percentages.

3.RESULTS AND DISCUSSION

3.1 Morphological Studies : Scanning electron microscopic investigation of the nano polymer composites infers the presence of nano particles of Zinc oxide in the pores of cured N**DBR** composites. Fig 2(a) shows the micrograph of the virgin polymer and it was observed that the distribution of particles are not uniform and particle size varies .They range from 3-12 μm in size and their chain formation is clearly visible. From SEM images, it was clear that virgin polymer exhibits porous nature while the pores disappear in the composite structure (Shahzada. A.et al 2007).This reveals that the nano particles of ZnO are intercalated into the polymer structure shown in fig 2(b).

Scanning Electron Microscopy

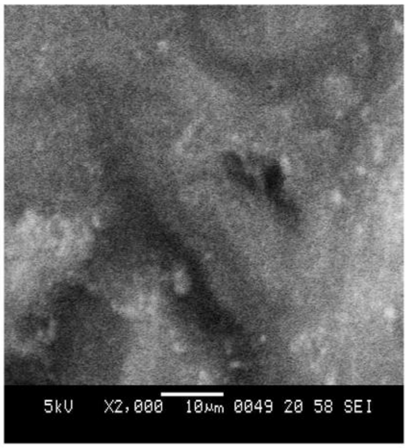

Fig 2 a.Micrograph of DBR

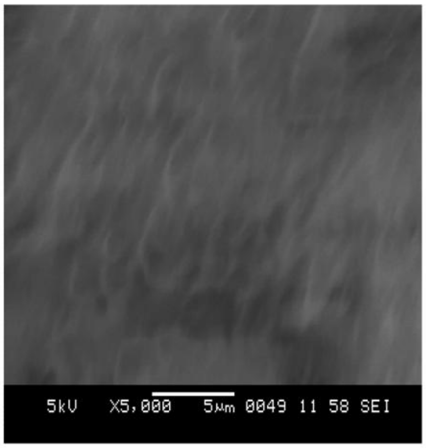

Fig 2.b Micrograph of NDBR -ZnO

3.2 Chemical Stability Test (ASTMD 543)

The Chemical resistance of the samples were evaluated by by immersing the small blocks in the different chemical reagents for 7 days .From the results , it was found that the nano composites of polymers are more stable towards chemical attack compared to polymer alone (Tawfik.M.E et al 2007)

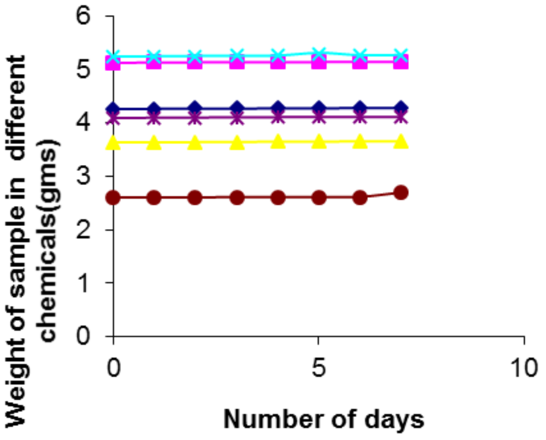

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Fig 3

🟦 - 10%HCl

🟪 - 10%H_2SO_4

🟨 -10% HNO_3

🟦 -10% NaOH

🟪 -10% NH_4OH

🟥 -10% Na_2CO_3

3.3 FTIR –Spectroscopic Study

FTIR spectra of **DBR(P1), DBR-ZnO(P2)** show that two are identical except few changes in the spectra of nano polymer composites .The features that are similar identify the presence of PMMA in all of them.The finger print frequencies of PMMA appear in the range 1731-1738 cm^{-1} (V c=o) and 1449 -1451 cm^{-1} (V c-o). The bands in the range 2994-3000 cm^{-1} corresponds to C-H stretching of methyl group (CH_3) while the bands at 1350 and 1450 cm^{-1} are associated with C-H symmetric and asymmetric stretching modes respectively. The 1241 cm^{-1} bands is assigned to torsion of methylene group(CH_2) and 1149 cm^{-1} band corresponds to vibration of the ester group c-o.The c-c stretching modes are at 1062 cm^{-1}& 993 cm^{-1}.Absence of any additional bands other than those of **DBR** in the spectrum of **NDBR-ZnO** indicate the formation of the nano composites and purity of the polymer. The additional band appears at 609 cm^{-1} due to the Zinc oxide particle alone.The FTIR spectra of the resin and resin containing ZnO in their matrices were compared. The carbonyl stretching frequency of PMMA which appeared at 1633cm^{-1} was unchanged after the reaction .This shows that lone pair of electrons present in the oxygen atoms of polymers are responsible for stabilization of nano particles. These electrons appear to be co-ordinating with atoms on the surface of **NDBR-ZnO** leaving Zinc oxide atoms inside the bulk unaffected. Similar phenomenon of stabilization of nano aluminium particles by a lone pair of electrons present in nitrogen and oxygen atoms of poly (vinyl pyrrolidone)and poly (methylmethacrylate) matrices have been reported(Sekher R.G).

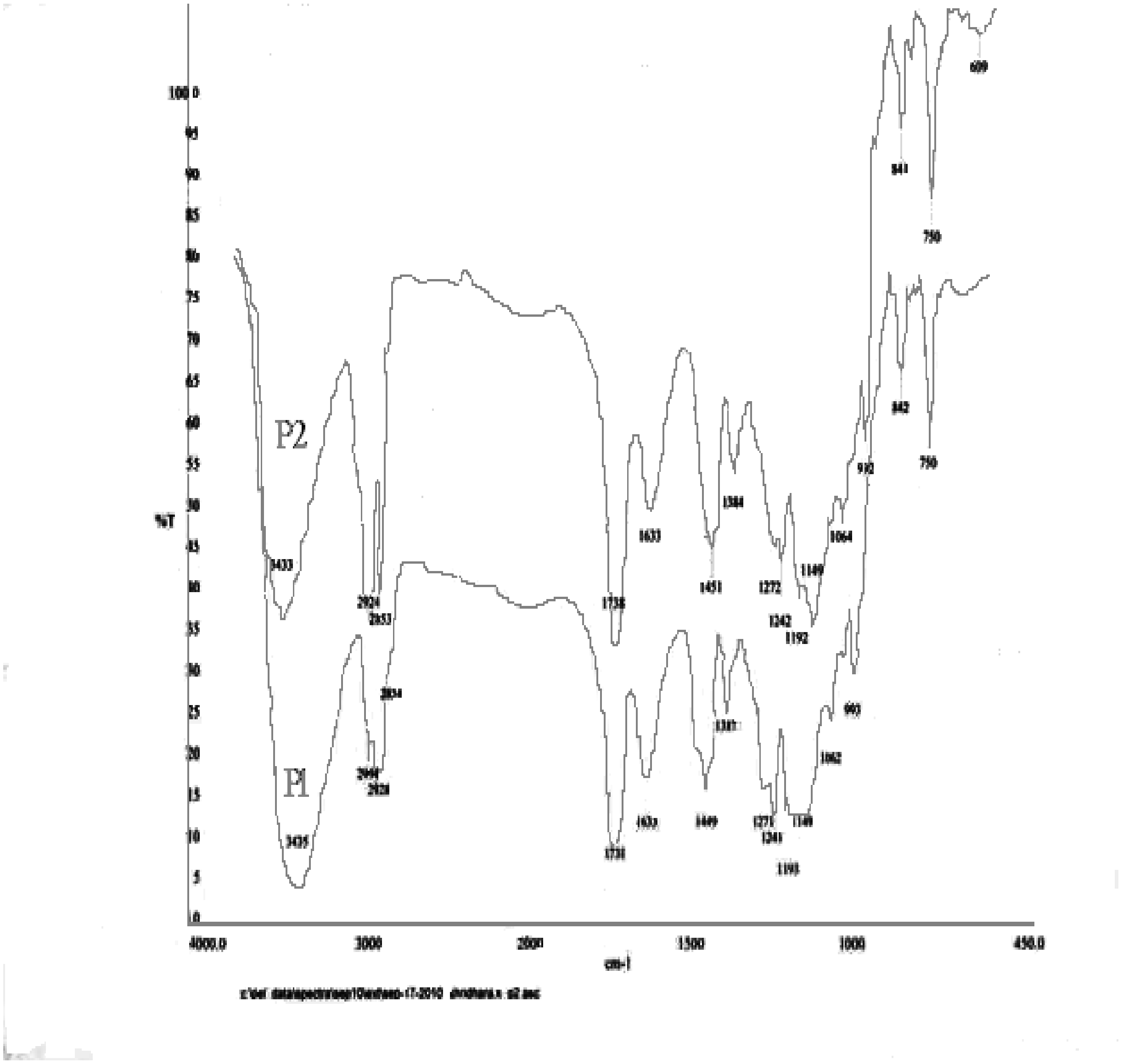


Figure 4

3.4 Thermal Studies

The Thermal stability of **NDBR –ZnO** composite were investigated by TGA and DTA analyses(Fig.5(b)) and compared with that of Pristine DBR (Fig5(a)).Main thermal event was endothermic depolymerization around 350 ^{o}C and accompanied by a small endotherm.This observation indicated that depolymerization started at 341.7 ^{o}C for the pristine polymer DBR. On the contrary , the start of depolymerization was retarded in the composite which is clear from the graph. Weight decrease started around 350 ^{o}C which is nearly 10 ^{o}C higher than pristine polymer. Therefore, inorganic network in the composite raised the thermal stability of NDBR moiety.The TG trace of these showed the stability of NDBR composites with that of polymer. As the polymer matrix was disintegrated by thermal depolymerization , composite network started shrinking diffusing inorganic filler particles to the matrix. This phenomenon is similar to shrinkage of Xerogel caused by capillary stress during drying step(Brinker C.,et.al 1990)The DBR composites show slightly less stability at 197 .3 ^{o}C due to physisorbed water evaporating at this temperature .

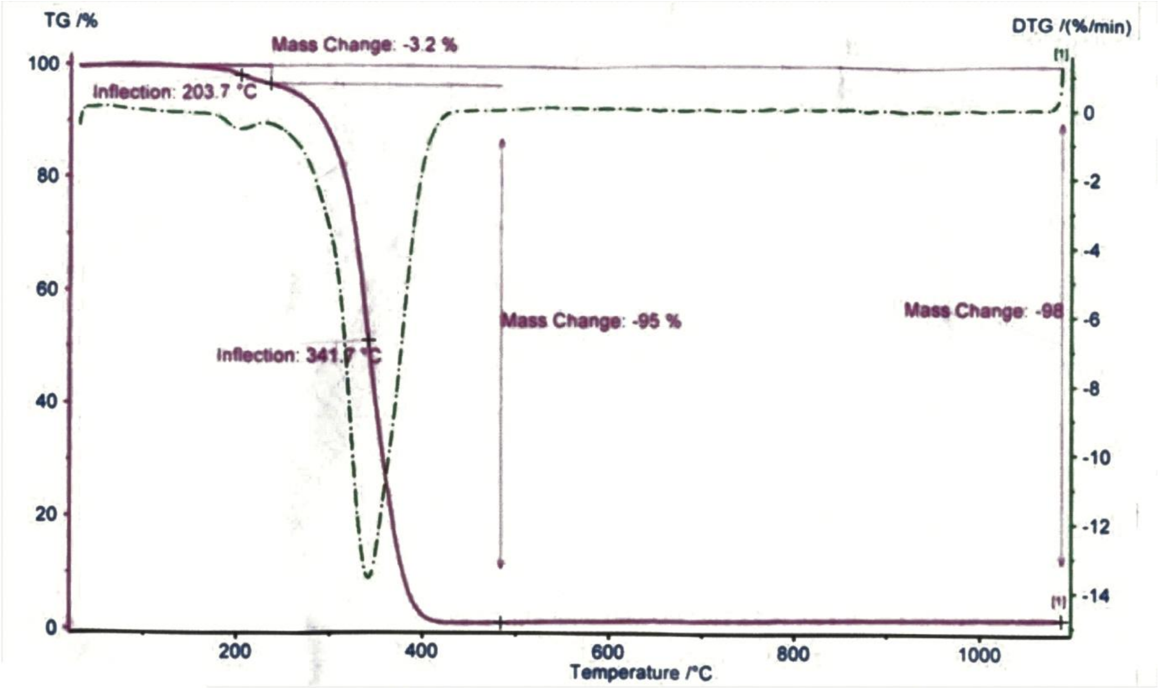
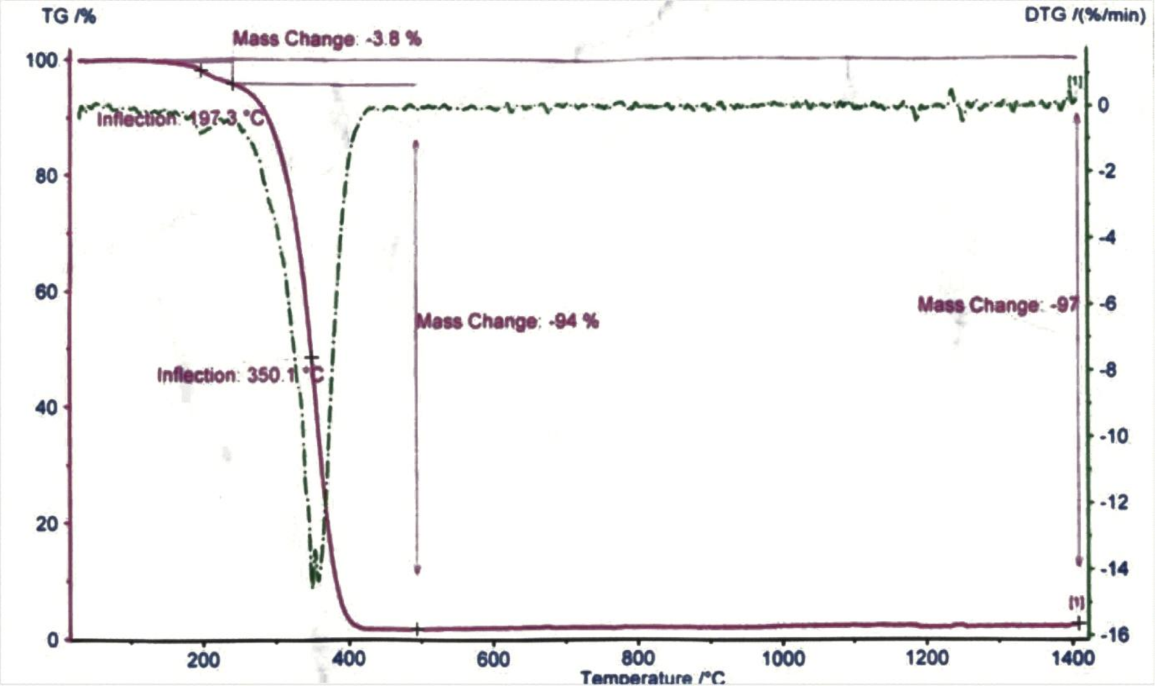


Fig 5(a) and Fig 5(b)



3.5 Hardness Test

Brinell hardness was determined by forcing a hard steel or carbide sphere of specified diameter under specified load into the surface of a material and measuring the diameter of the indentation left after the test . The Brinell hardness number is obtained by dividing the load used in kilogram, by the actual surface area of the indentation in square millimeter.

BHN is calculated using the formula

$$BHN = \frac{2P}{\Pi D(D-\sqrt{D^2-d^2})}$$

Where P = applied force or load

D =Diameter of indenter
d = diameter of indentation

Brinell test methods are defined in the following standards.

*ASTME -10 * ISO 6506

Table.I Comparison of Hardness Parameters for DBR and NDBR-ZnO .

Serial No.	Material	Brinell Hardness number
1	DBR	78.071
2	NDBR-ZnO	112.378

*Mean of Ten determinations

Brinell hardness number of the polymer sample and nano composites of the polymer were compared. By comparison, it was observed that intercalation of ZnO particles on the polymer matrix increases the Brinell hardness number.

4. CONCLUSIONS

- Surface texture of the dentures can be significantly by using functionalized nano zinc oxide particles.
- 1 % by weight is a ideal candidate for further investigation.
- The structural integrity of the denture base resin has been improved.
- The strength of the specimen prepared from nano composites of zinc oxide denture base resin has been markedly improved.
- Thermal stability and chemical stability values are higher than pure one.
- These may be useful for further study inside the mouth of patients.

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