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# Development of Nanocomposites of Self Cure Denture Base Resins with Magnesium Oxide.

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## Abstract

The denture base resins are mainly used for preparation and repair of dentures. The self cure denture base resin (SCDBR) suffers from many drawbacks like porosity, tear strength, thermal stability, hardness etc. We have incorporated nanometric magnesium oxide particles to minimize the defect to some extent .The objective of our investigation is to evaluate its performance by scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FT-IR ) ,Chemical stability, Hardness test and Impact test. These characterization methods showed remarkable improvement in its properties.

Key words: Self Cure Denture base resins, Nanometric MgO, Nanocomposites, porosity ,filler.

## 1.Introduction

The incorporation of metal nanoparticles into polymer network opened a new horizon in the field of science. Dentures play a vital role in improving the quality of life of edentulous patients .Denture base resins are significant in dentistry to imitate the natural gum tissues in dentistry. Poly (methyl methacrylate ) is one of the major ingredient in self cure and heat cure denture base resins. Dentures which are prepared from SCDBR gained less momentum due to its porosity , chemical stability , tear resistance , hardness compared to heat cure denture base resins [1].Acrylic resin dentures are noted for their tendency to absorb water which causes corresponding dimensional changes and hydrolytic degradation of polymers [ 2 ]. The role of various metal oxides on mechanical and physical properties of heat cure denture base resins were studied [ 3 ].Nano magnesium oxide attracted much attention due to its various applications. Magnesium oxide has been used as an adsorbent for removing dyes and heavy metals from waste waters [4,5] . It has very good bactericidal performance in the aqueous environment due to the formation of super oxides.[ 6,7 ] .It has also been used as catalyst and catalyst support for various organic reactions[8,9].Due to this unique physicochemical properties including high surface area to volume ratio, attracted our attention to choose magnesium oxide. In the present study , we have introduced nanoparticles of MgO as a filler to the self cure denture base resin and analyzed the various morphological , physical , chemical and mechanical properties .

## 2.Experimental

## 2.1.Instruments

FTIR spectra was obtained using an FTIR spectrometer (Perkin Elmer Inc-spectrum 100 FT-IR Spectrometer). Potassium bromide disk was used as beam splitter in wave –number region

4000-400 $cm^{-1}$. Scanning electron microscopy was carried out using Joel Scanning electron microscope. Brinell hardness number was determined by forcing a hard steel ball under specified load into the surface of a material and measuring the diameter of the indentation left after the test. Charpy test was carried out using Charpy impact tester.

## 2.2 Synthesis of Nanocomposites of Self Cure Denture Base Resins (NSCDBR)

In our proposal of in situ polymerization technique , liquid containing monomer methyl methacrylate (MMA) and polymer powder containing poly (methyl methacrylate )( PMMA) of self cure denture base resins(SCDBR) were mixed in the ratio 1 :3 by volume were placed in a porcelain jar . Then it was allowed to 3-5 minutes for curing along with 0.1 gm of nano metric magnesium oxide dissolved in 0.1 M hydrochloric acid. The samples of 2 X 2 X 0.5 cm dimensions were prepared by pouring the putty consistency of the polymer in to molds using filled and unfilled resins of magnesium oxide. (Fig. 1) Magnesium oxide particles were prepared from 0.2 M $MgNO_3$ by previous method [10].

Fig.1 Samples of SCDBR and NSCDBR - MgO.

## 3.Results and Discussion

Scanning electron microscopy reveals the presence of nanoparticles of magnesium oxide in the cavities of cured NSCDBR composites. Fig 2 (a) shows the distribution of particles in the network. They range from 2-12 µm in size and their chain formation is visible from the images. It was evident from the graph that pure resin exhibits porous nature while the pores disappear in the composite structure[11] .This confirms the presence of intercalation of nanoparticles in to the polymeric network (Fig . 2 a & b ).

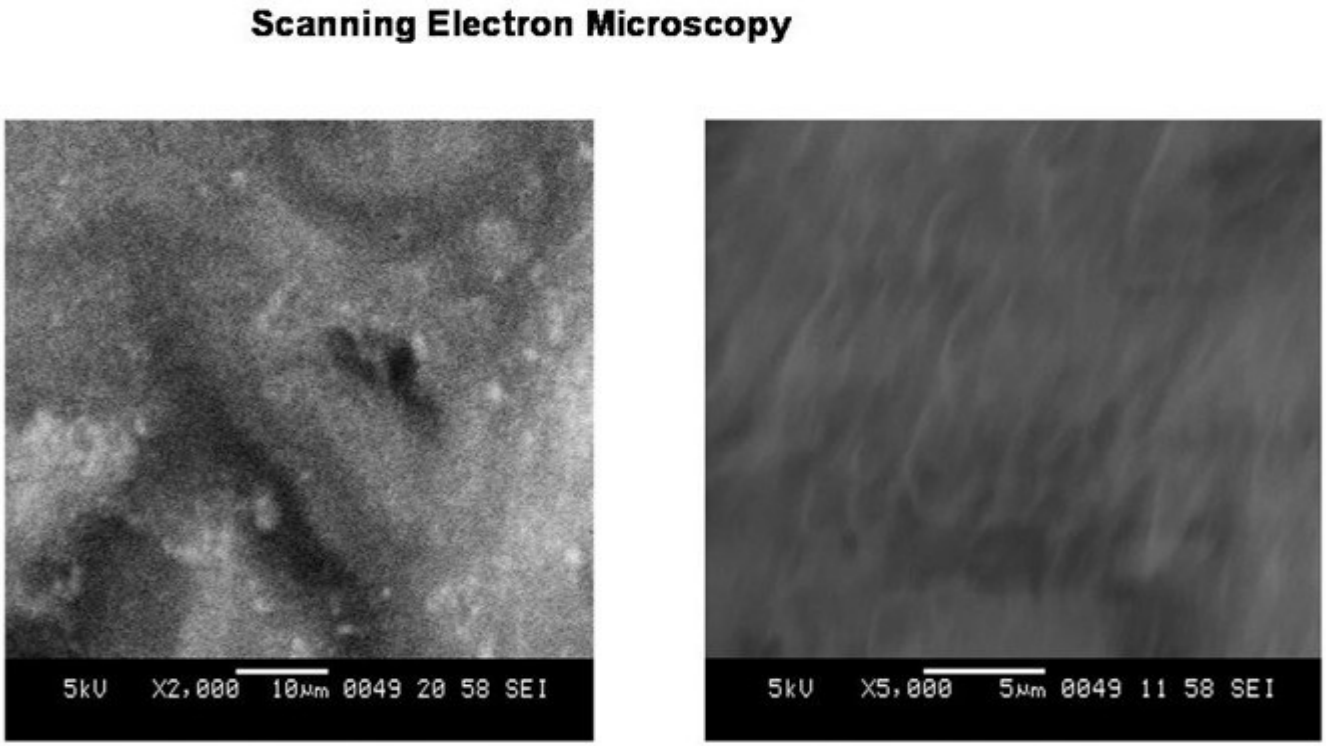


Fig 2 a.Micrograph of SCDBR

Fig 2.b Micrograph of NSCDBR-MgO

Figure 3 shows the chemical stability test (ASTMD 543 ) results of the samples which were analyzed by immersing the blocks in various chemical reagents for a week .From the plot , it was observed that the nano composites of polymers are more resistant towards chemical attack compared to unfilled resin [12].

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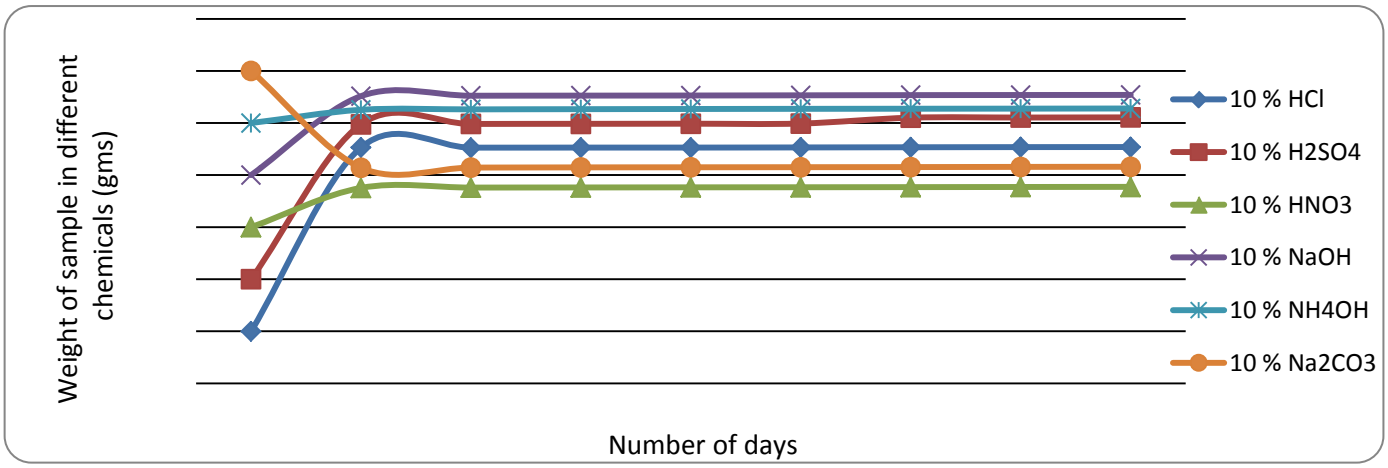


Fig .3 Chemical stability of NSCDBR- MgO .

Fourier transmission infra- red spectra of filled and unfilled resins of magnesium oxide show that two are identical except few changes in the spectra of nano polymer composites. The presence of PMMA can be identified from both spectra.The finger frint frequencies of PMMA appear in the range 1731-1738 $cm^{-1}$ ($V_{c=o}$) and 1449 -1451 $cm^{-1}$ (Vc=o) and 1449 -1451 $cm^{-1}$ (Vc-o) .The bands in the range 2994 - 3000 $cm^{-1}$ corresponds to C-H stretching of methyl group ( $CH_3$) while the frequencies at 1350 and 1450 $cm^{-1}$ are associated with C-H symmetric and asymmetric stretching modes respectively. The band at 1241 $cm^{-1}$ is assigned to torsion of methylene group ($CH_3$) and 1149 $cm^{-1}$ band corresponds to vibration of the ester group c-o. The c-c stretching modes are at 1062 and 993 $cm^{-1}$. Absence of any additional bands other than those of MgO unfilled resin in the spectrum of nano MgO filled denture base resin indicate the formation of nanocomposites and purity of the resin.The additional band appears at 449 $cm^{-1}$ is due to the magnesium oxide particle alone[13] . The FTIR spectra of the resin and resin containing MgO in their matrices were compared . The carbonyl stretching frequencies of PMMA which appeared at 1633 $cm^{-1}$ 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. Thee electrons appear to be co-ordinating with atoms of polymers are responsible for stabilization of nanoparticles.Thses electrons appear to be co-ordinating with atoms on the surface of NSCDBR-MgO leaving magnesium oxide atoms inside the bulk unaffected . This phenomenon is similar to the stabilization of nano aluminium particles by a lone pair of electrons present in nitrogen and oxygen atoms of poly (vinyl pyrrolidone ) and poly (methyl methacrylate ) matrices [14].

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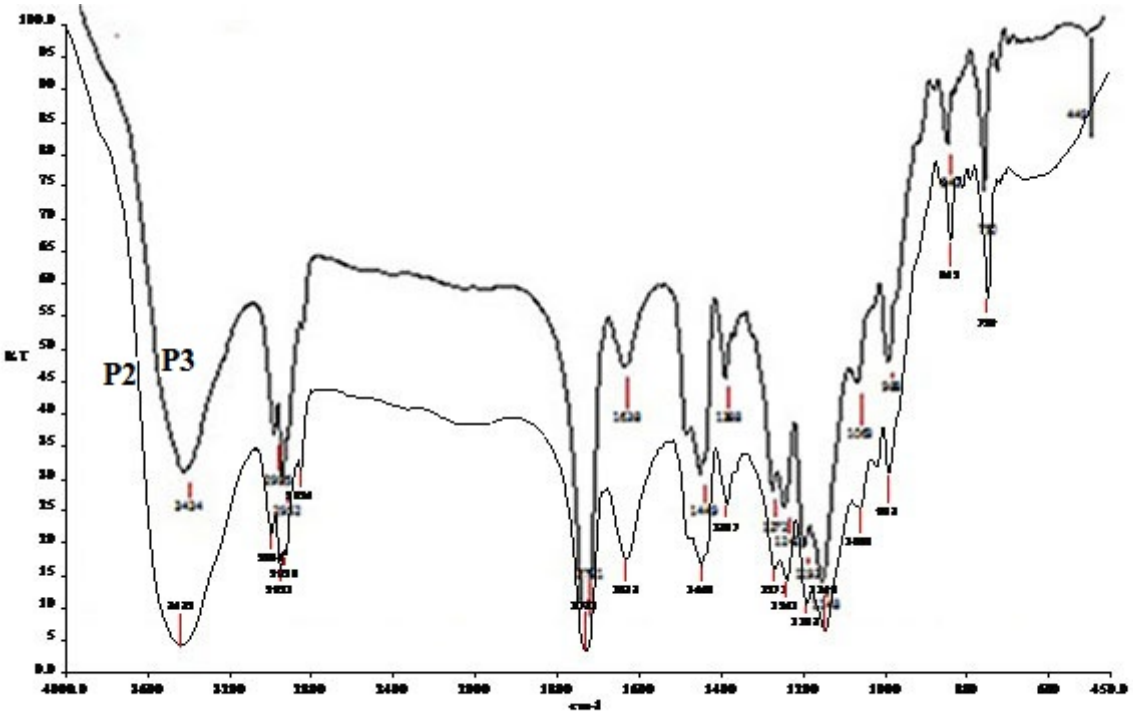


Fig.4 Combined FTIR –Spectra of NSCDBR- MgO and SCDBR .

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

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

P= Load, D =Diameter of indenter, d = diameter of indentation

Brinell test methods are defined in the following standards.

*ASTME -10 * ISO 6506

**Table.1 Comparison of Hardness Parameters for SCDBR and NSCDBR-MgO .**

| Serial No | Material | Brinell Hardness number |
|---|---|---|
| 1 | SCDBR | 76.876 |
| 2 | NSCDBR-MgO | 110.688 |

*Mean of Ten determinations

Brinell hardness number of the resin and nano composites of the resins were compared. It was observed that intercalation of MgO particles on the polymer matrix enhances the Brinell hardness number.

The impact force that the sample can tolerate is evident from the results of the study given in Table 2. Comparative studies of impact strength values of nano composites of SCDBR with SCDBR alone shows supportive evidence to dimensional stability of nano composites.

**Table 2: Izod Impact Strength Measurement**

| Sl. No. | Material | Breadth of specimen in mm | Depth of specimen in mm | Area in $mm^2$ | Reading on charpy | | Net Reading in mm | Impact Resistance $Kg/mm^2$ | Average Impact Resistance $Kg/mm^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | $R_1$ | $R_2$ | $R_1 \sim R_2$ | | |
| 1 | SCDBR | 1 | 3 | 3 | 19.8 | 19.7 | 0.1 | 0.0334 | 0.0334* |
| 2 | NSCDBR-MgO. | 1 | 3 | 3 | 19.9 | 19.7 | 0.2 | 0.066 | 0.066* |

*Mean of Ten determinations

## 4.Conclusions

Surface modification of the dentures can be remarkably improved by using functionalized nano magnesium oxide particles.1 % by weight MgO is a suitable for further studies.The strength of the specimen synthesized from nano composites of magnesium oxide denture base resins has been showed better results.Chemical stability values of filled denture base resin are higher than pure resin .Hardness and impact strength revealed the greater dimensional stability of nano polymer composites of MgO.These may be further studied inside the mouth of the patient after biocompatibility studies.

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