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Article

Impact of Shore A hardness and Surface roughness of Room Temperature Maxillofacial Silicone after the addition of Nano Barium Titanate

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Abstract

To achieve patient acceptability, maxillofacial prosthetic materials should have desirable and ideal physical, cosmetic, and biological features that can be maintained for a long time. The mechanical qualities of the prosthetic material, as well as color degradation, are the most typical reasons for re-making maxillofacial prostheses. This study evaluated the effect of adding Barium Titanate (BaTiO3) Nanofillers in different concentrations on the surface hardness and surface roughness of VST-50 room-temperature vulcanized maxillofacial silicone. In the FTIR, there was no interaction between Nano-BaTiO3 and VST-50 silicone. After adding BaTiO3, an AFM image revealed the surface topography or morphology of the silicone surfaces of specimens, as well as an increase in the roughness of the VST-50 silicone elastomer. When compared to the control group, the 1% more hardness and less roughness than the 2 % groups. VST-50 maxillofacial silicone was reinforced with 1% and 2% Nano BaTiO3 concentrations, which improved numerous mechanical properties of the room-temperature vulcanized silicone.

Keywords: Shore A hardness, Maxillofacial Silicone, Nano Barium Titanate, Surface topography.

Introduction

The face is the first portion of the body to come into contact with the outside world; the accepted appearance of the face is now required to be accepted in a job, to appear in a magazine or on television, and to look good in a marriage [1] The most often utilized substance for face repair is silicone. Polymeric materials, on the other hand, are highly versatile, yet their performance still needs to be improved due to their low thermal resistance to solar radiation [2]. Many factors influence the mechanical properties of a silicone elastomer, including the molecular weight of polymer chains, the presence of filler, and crosslink density [3]

Certain Nanofillers, such as titanium silicate, are added to the matrix to improve the mechanical characteristics of RTV maxillofacial silicone, which improved the mechanical properties of RTV maxillofacial silicone [4]

Nano barium titanate (NBT), as a family of
ceramic materials, offers potential for biological applications due to its superior mechanical properties [5]

This research aimed to show the effect of the weight percentage of BaTiO3 on the shore. A hardness test and surface roughness test of VST-50 RTV maxillofacial silicone.

Materials and Methods

The materials used in this study are listed in (Table 1).

Two main groups were used, one for the shore A hardness test and the other for the surface roughness test. Each leading group was subdivided into three subgroups, one for control 0% (without Nano addition), and 1%, 2% by weight Nano BaTiO3 groups, each with 10 samples. Plastic molds were made with a CNC machine, and each mold has the same proportions for the base, frame, and cover sections.

According to the manufacturer's instructions, the VST-50 room temperature vulcanized maxillofacial silicone type employed in this study is a two-part silicone with a 10:1 base-to-catalyst mixing ratio. The control group's mixing began with adding the base to the electronic balance container, followed by the catalyst and mixing with the vacuum mixer at 140±10 rpm and -0.095 MPa (28-inch Hg). For the reinforced groups, Nanopowder was first placed in the electronic balance container, followed by the base, and then mixed without vacuum for 3 minutes, vacuum mixing for 7 minutes, catalyst addition, and vacuum mixing for the last 5 minutes, [6]

After pouring the silicone into the shore A hardness and surface roughness test molds, G-clamps were utilized to fasten the lid over the remaining mold pieces. After 24 hours of complete vulcanization, the mechanical properties of RTV silicone were investigated.

The hardness test was performed using a digital shore A hardness durometer equipment by ASTM D2240-05 [7], a sample with a length of 25 mm, a width of 25 mm, and a thickness of 6 mm. while a profilometer measured the surface roughness, the dimensions of roughness is identical to hardness test.

The FTIR measures the transmission or absorption of infrared light at different frequencies to identify the material's spectral fingerprint [8]

Using an atomic force microscope, the topography or morphology of the silicone surfaces of specimens was studied and compared (AFM model TT-2, USA). A probe with a tiny cantilever and a sharp tip was used to scan the sample surface.

Results

Using the one-way ANOVA test, the statistical findings of the shore A hardness test demonstrated a substantial increase in the 1% and 2% groups, with P values less than 0.05. In a one-way ANOVA test, the surface roughness tests revealed a significant increase in the 1% and 2% groups, with a P value less than 0.05. (Tables 1 and 2).

Groups	**Minimum**	**Maximum**	**Mean**	**±SD**	**F**	**P value**
0%	30.000	34.40	32.0800	1.456063	29.564	**0.132**
Ba-TiO3						
1%	34.50	37.20	35.75	0.87		

			00	210		
Ba-TiO3						
2%	32.80	35.80	34.81 00	0.89 747		
Ba-TiO3						

Table 1: Statistical test of Shore A hardness (IU).

Groups	Minimum	Maximum	Mean	±SD	F	P value
0%	0.223	0.553	0.36 190	0.10 168 8	20. 95 5	**0.87 2**
Ba-TiO3						
1%	0.352	0.692	0.51 150	0.11 132 6		
Ba-TiO3						
2%	0.526	0.868	0.67 210	0.10 826 1		
Ba-TiO3						

Table 2: Statistical test of Surface roughness(μm).

The FTIR analysis showed no interaction between the BaTiO3 Nanofillers and the VST-50 maxillofacial silicone (Figure 1, 2 & 3)**.**

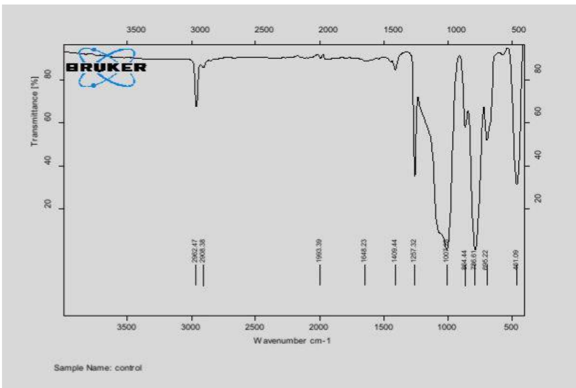

Figure 1: FTIR of the VST-50 maxillofacial silicone before the addition of BaTiO3 Nanofillers.

The surface topography or morphology of the silicone surfaces of specimens, as well as surface roughness, were visible in the AFM image**.**

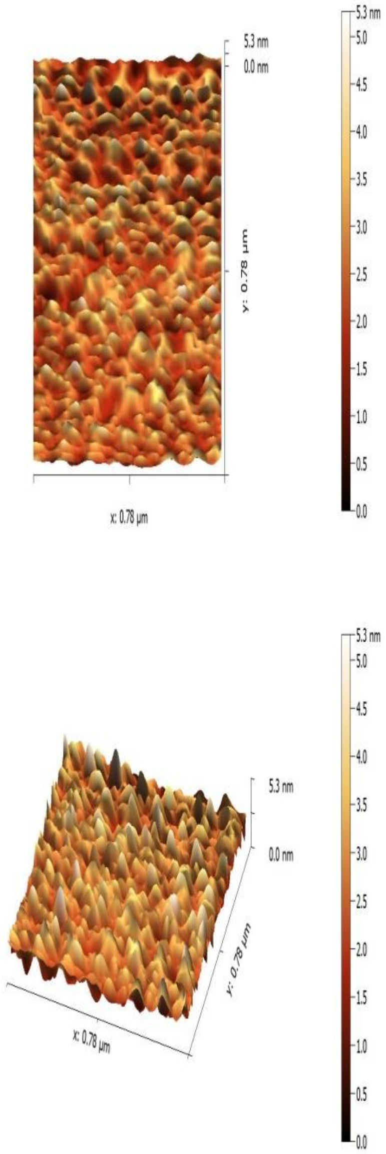

Figure 2: AFM for VST-50 maxillofacial silicone before the addition of BaTiO3 Nanofilers.

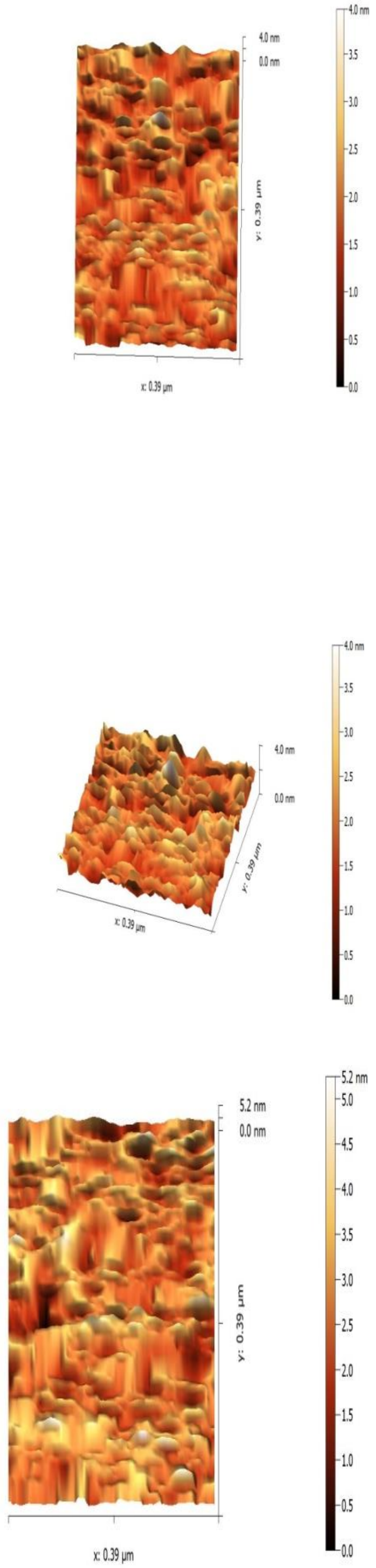

Figure 3: AFM for VST-50 maxillofacial silicone with 1% BaTiO3 Nanofillers.

Discussion

Barium titanate Nano fillers were chosen to be added because they offered various advantages over other Nano filler types, as many previous studies had shown that adding fillers on a Nanoscale improved the mechanical characteristics of maxillofacial silicone [5]

The results showed an increase in hardness test due to the dispersion of the nanoparticles and the creation of filler-filler networks inside the silicone matrix and between the polymeric chains, which fills the inter-aggregate spaces, which can explain the rise in hardness values after the addition of 1wt% and 2wt% BaTiO3. This action can make the material more challenging by increasing its resistance to indentation and penetration [15,16,17]

Conclusions

Adding 1% and 2% Nano BaTiO3 to VST-50 RTV maxillofacial silicone improved some of the silicone's mechanical qualities.

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