

# Study on Antibacterial Property of PMMA Denture Base Materials with Negative Ion Powder

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**Abstract.** To prepare the denture base resin with negative ion powder and evaluate the antibacterial effect of denture base resin with different contents of negative ion powder for clinical application. Method: Denture base material with negative ion powder was prepared by in-situ polymerization method, 50mm \* 50mm \* 2mm standard samples were prepared respectively. Antibacterial properties were tested with the film contact method. Experimental bacteria: Staphylococcus aureus (ATCC6538), Escherichia coli (ATCC8099). Result: With the increase of the amount of negative ion powder, the inhibition rate of the composite material to Escherichia coli and Staphylococcus aureus showed an increasing trend, and the number of residual bacteria on the surface showed a decreasing trend. When the content of negative ion powder was 2%, the composite material Staphylococcus aureus and Escherichia coli were 77.9% and 80.3% respectively. When the addition ratio was 5%, the bactericidal rate of the composite material to Staphylococcus aureus and Escherichia coli reached 98.2% and 99.1% respectively. Conclusion: The denture base material containing more than 2%wt negative ion powder has strong sterilization.

**Keywords:** Polymethylmethacrylate; Negative ion powder; Denture; antibacterial effect

## 1. Introduction

Poly (methyl methacrylate) is a commonly used material for the preparation of removable partial denture and full denture base, with the advantages of low cost, easy operation and easy repair. Denture base material surface roughness and hydrophobicity and other issues can promote the denture base surface adhesion of microorganisms and accelerate the formation of biofilm, After long-term wear the denture base into the oral cavity, easily lead to denture stomatitis. Prevention of denture stomatitis has become one of the important issues that dental practitioners work together to solve. The study found that *Candida albicans* was usually considered the main pathogens of denture base material surface. It was easy to adhere to the denture base material surface and difficult to clean, often leading to the occurrence of inflammation denture. Antifungal therapy had a certain effect, but anti-fungal agents could lead to drug-resistant strains. We envisioned to add antimicrobial-containing materials into the denture base material, Hoped that through the role of its composite material to play against the common role of oral bacteria, denture base material on the surface of the number of bacteria is reduced to achieve the role of prevention of denture stomatitis. Yoshida et al[1]. showed that the composite resin containing 5% wt silver antimicrobial agent could still inhibit the growth of *Streptococcus mutans* after three months of immersion in distilled water, and the compressive strength and flexural strength properties without impact. Studies have shown that anion powder with excellent dispersibility and antibacterial properties by sol-gel method using Na<sub>2</sub>SiO<sub>3</sub> as coating agent. And



successfully developed functional coatings with different concentrations of negative ion powder, Its antibacterial properties were studied, the results showed that the functional coatings with negative ion powder had antibacterial properties [2-4]. We proposed to add it to the denture base material, prepare the denture base material containing the negative ion powder, and study the antibacterial properties of the composite material containing the negative ion powder composite resin, and provide some theoretical basis and experimental basis for the future clinical application.

## 2. Experimental Materials and Equipment

### Experimental materials

name	factory
Anion powder	Ultra-fine powder from the processing of the laboratory, Shijiazhuang, Hebei
Anhydrous ethanol	(Tianjin) Pharmaceutical and Chemical Company Limited
Glycidyl methacrylate(GMA)	Shiphan Chemical(Shanghai)Co., Ltd
N, N-dimethylformamide(DMF)	(Tianjin) Pharmaceutical and Chemical Company Limited
High - purity deionized water(DW)	Millipore,USA
Fused denture base powder and water liquid	Dentsply Dental Corporation
Silicon nitride ceramic ball	Shanghai Xinmao Precision Ceramic Technology Co., Ltd

### Experimental equipment

name	factory
Super clean working table	SW-CJ-IFD,China,Jiangsu
Stainless steel steam sterilizing device	Shanghai,CHINA Miaojie
Metallographic sample polishing machine	Laizhou city Wei instrument test equipment manufacturing Co., Ltd.
Ultrasonic cleaner	BRANSON 200

## 3. Sample Preparation Method

The non-treated negative ion powders were added into the denture base material by ball-milling blending method, respectively, with 0%, 1%, 2%, 3%, 4% and 5% Speed 900rpm, time 1h. According to the denture base manufacturing process, the composite denture powder and denture water are mixed according to the ratio of 2: 1 (weight ratio), and evenly mixed with a stainless steel knife and gently shaken. When the dough period was filled in the plaster model, Polyethylene film on the rear cover type box, slowly pressurized open type box, peeled off the polyethylene film, removed the excess material around, and then covered with lid and pressed in the box press. Put in cold water to boil, turned off the heat for 30 minutes, cooked until boiling, boiling water for 20 minutes in the continued, cooled to room temperature, opened the box, removed the embryo-like, with 500,600,800 water sandpaper grinding and polishing, so that the upper and lower surface parallel and smooth. Using the above methods, 50mm×50mm×2mm standard sample were prepared and numbered them.

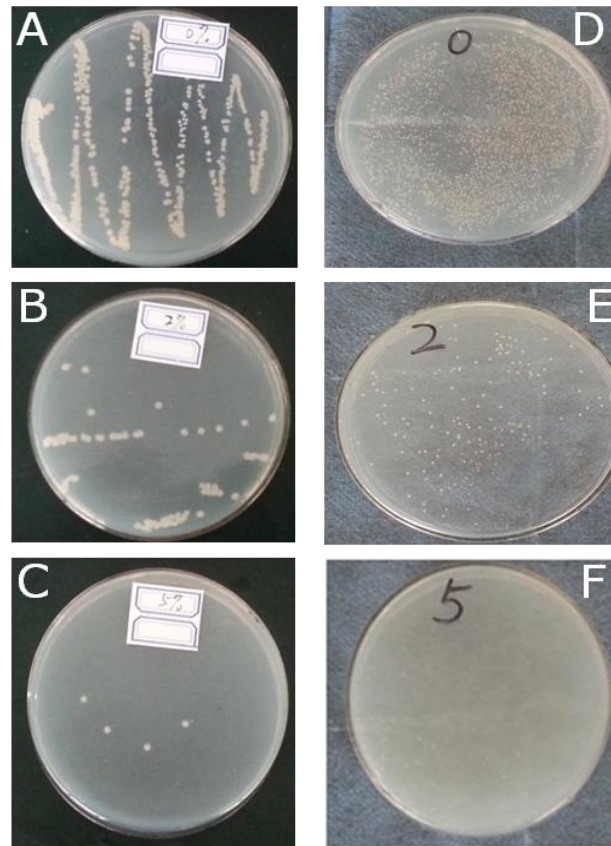
## 4. Antibacterial Properties Test

The antibacterial test was carried out using the National Film Attachment Method (QB / T 2591-2003), Experimental strains: Staphylococcus aureus (ATCC6538), Escherichia coli (ATCC8099), Experiment procedure: With the disinfection method of high temperature and high pressure to denture base material (50mm × 50mm × 2mm) with negative ion powder(0% wt, 1% wt, 2% wt, 3% wt, 4% wt, 5% wt), Respectively, to absorb 10ul 5 × 10<sup>6</sup>CFU / ml concentration of bacteria dropped on the sample surface, covered with sterile PE film, so that evenly distributed. The samples were then placed in a 10 ml PBS solution sterile shaker for 1 minute. Respectively, take 50ul inoculated in Staphylococcus aureus, Escherichia coli nutrient agar plate. Staphylococcus aureus, Escherichia coli were Aerobic cultured for 24 hours and then counted the number of colonies.

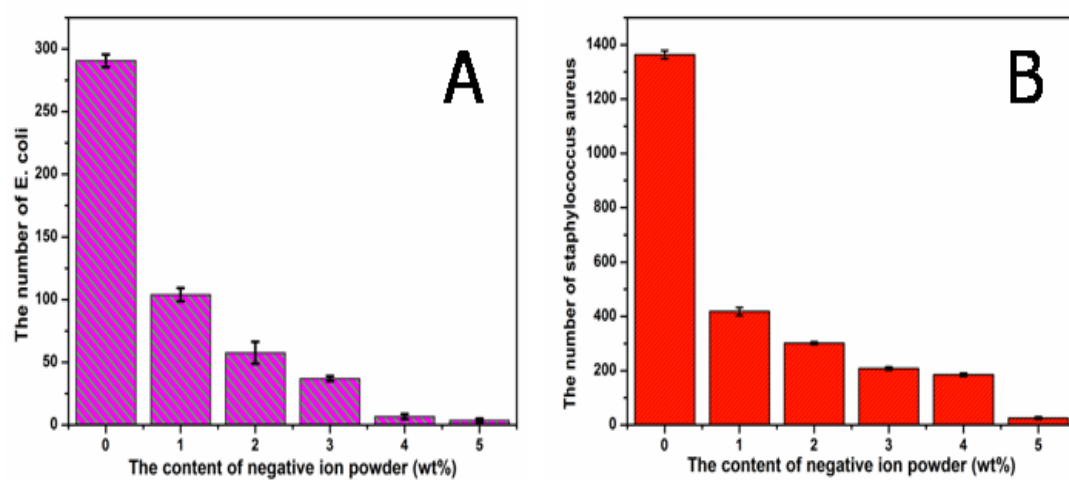
Calculated as follows: Antibacterial rate%  $(A-B) / A * 100\%$

(A-the average number of bacteria in the control sample, B-the average number of bacteria in the test sample).

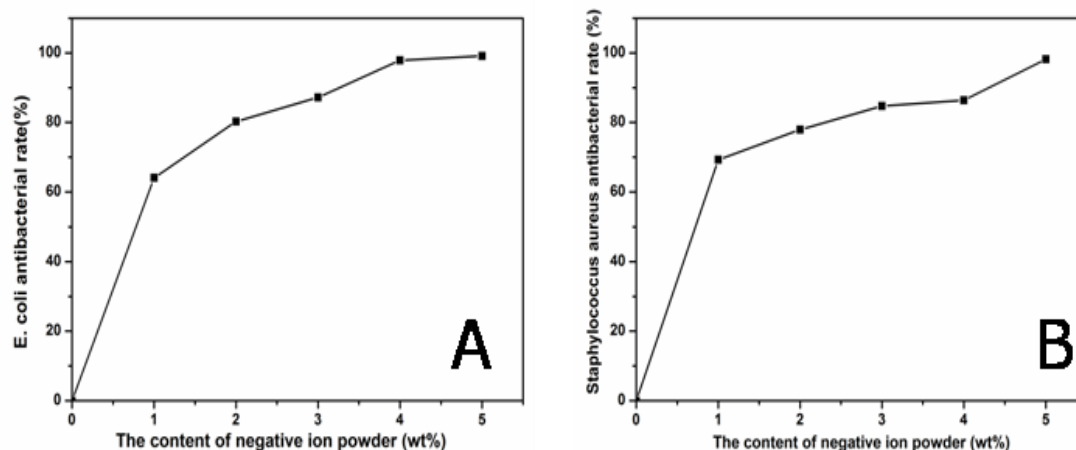
## 5. Results and Discussion



**Figure 1.** (Escherichia coli: A :0% ,B:2%,C:5%; Staphylococcus aureus:D:0%,E:2%,F:5%)



**Figure 2.** The residual bacteria quantity on the PMMA denture base containing negative ion powder (A: Escherichia coli;B: Staphylococcus aureus)



**Figure 3.** Change trend curve of inhibition rate of PMMA denture base containing negative ion powder (A: *Escherichia coli*; B: *Staphylococcus aureus*)

Fig 1 is the physical map of the experiment; we can see that with the increase in the content of negative ion powder, the number of bacteria on the denture base surface showed a downward trend. For *Escherichia coli*, antibacterial C > B > A, and for *Staphylococcus aureus*: F > E > D, as shown in Fig 2. With the increase of the amount of negative ion powder, the inhibitory rate of the composite material to *Escherichia coli* and *Staphylococcus aureus* showed an increasing trend (as shown in Fig. 3), and the number of residual bacteria on the surface showed a decreasing trend (as shown in Fig. 2). When the content of negative ion powder was 2%, the bactericidal rate of the composite material to *Staphylococcus aureus* and *Escherichia coli* was 77.9% and 80.3% respectively. When the ratio was 5%, the bactericidal rate of the composite material to *Staphylococcus aureus* and *Escherichia coli* was 98.2% and 99.1%. As GB15975-1995 (product antibacterial and bactericidal performance and stability of the experimental method) provides that the bactericidal rate of the material on the microbes is higher than 50% can be called antibacterial material, sterilization rate greater than / equal to 90% only have a strong bactericidal. Therefore, the denture base material with negative ion powder has a strong bactericidal. This is because with the increase in the amount of negative ion powder, with anionic powder denture base material surface metal cation significantly increased, metal cations can destroy the bacterial cell membrane, thereby reducing the activity of cell activity of enzymes, leading to bacterial death [5].

Dentureous stomatitis was a common infectious disease. It was common in patients with full or removable partial denture. The main lesion is contact with the denture surface of oral mucosal inflammation and erythema, common in the elderly. Denture stomatitis caused by denture basement is one of the clinical manifestations of bacterial colonization on the surface of oral prostheses. It is necessary to develop antibacterial denture base material, because the denture base material is not easy to be disinfected and bacteria colonization and breed faster. With the continuous popularization of oral health knowledge, people's awareness of oral health care, medical antibacterial polymer resin base material will have a broad application prospects.

According to the literature, the number of dentin adhered to the surface of denture base with negative ion powder was significantly lower than that of conventional PMMA denture base material [6]. Polymer particles on the surface of the repulsion, blocked the adhesion of bacteria on the surface of the polymer [7,8]. The mineralization of the surface charged PMMA polymer is detected, and the polymer surface contains saliva antibiotics that impede adsorption [9]. The increase in the negative ion charge on the surface of the PMMA base material in the oral cavity can reduce the surface contact angle and the adhesion of bacterial.

The effects of negative ion powder on the physical and mechanical properties of PMMA base materials were studied. The results show that the PMMA matrix material can maintain the physical and mechanical properties of PMMA base material, and it has a strong antibacterial powder content. In this study, the effect of negative ion powder on the physical and mechanical properties of PMMA base

material was studied to find the powder content which could maintain the physical and mechanical properties of PMMA base material and had the strong antibacterial effect. So to develop the antibacterial oral denture base material applied to the practice of oral denture base.

## 6. Conclusion

The antimicrobial properties of PMMA denture base materials with negative ion powder were tested and evaluated by film adhesion method. With the increase of the ratio of negative ion powder (0% wt, 1% wt, 2% wt, 3% wt, 4% wt, 5% wt), the antibacterial rate of *Staphylococcus aureus* and *Escherichia coli* was gradually increased, The inhibitory rate was 98.2% and 99.1% when the amount of negative ion powder was 5% wt.

## 7. Acknowledgement

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