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SHORT COMMUNICATION

Definitive Dental Applications of Graphene Based Dental Biomaterial

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ABSTRACT

Graphene was first identified in 2004, and it has remarkable properties. Atoms of Graphene are very tightly bonded so, like carbon nanotubes, which makes it super-strong, even more, potent than diamond. Moreover, it has good Heat conductivity, Electrical conductivity, and optical properties. Application in the dental field, especially in prosthodontics, includes the addition to Polymethylmethacrylate and improving its properties. In removable and implant prosthodontics in the last five years, this biomaterial had evoked immense research interest.

INTRODUCTION

Graphene is stiff, amazingly thin, almost completely transparent, extremely light, and a tremendous conductor of electricity and heat. It also has some highly unusual electronic properties [1,2]. It is a single layer of graphite. It has a two-dimensional crystalline structure. As in graphite, each graphene layer is formed of hexagonal "rings" of carbon, giving a honeycomb-like appearance [1,2].

GENERAL PROPERTIES

Strength and stiffness

It is both stiff and elastic. It can be stretched by a tremendous amount (20-25 percent of its original length) without breaking because the flat planes of carbon atoms in graphene can undergo flexion easily [1,3,4]. It has the tensile strength of 130 gigapascals [3,4].

Thinness and lightness

Graphene is one atom thick and also very light. The thickness of graphene is between 0.4 to 1.7 nm [3,4].

Heat conductivity

Graphene has a very high thermal conductivity. The thermal conductivity of graphene is in the range 3000 - 5000 W/mK at room temperature [3,4].

Electrical conductivity

Graphene has excellent electrical conductivity. The electric conductivity of graphene is as high as 10^4–10^5 S/m [3,4].

Optical properties

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Photons can penetrate through thin layers of graphene than thick ones. Sheets of graphene have such close-knit carbon atoms that they will work like super-fine atomic nets, stopping other materials from getting through [3,4].

GENERAL APPLICATIONS

- As an Energy storage unit and in solar cells
- Sensor applications
- Graphene ink
- Used in transistors and memory Flexible, and stretchable electronics, Photodetectors

APPLICATIONS IN PROSTHODONTICS

1. Addition of graphene in Polymethylmethacrylate resin (PMMA) increases the resin's mechanical properties, decreases the degree of contraction during polymerization, and exhibits better antimicrobial-adhesion effects [5]. Polymerisation of PMMA triggers an exothermic reaction. Graphene has excellent heat conductive property and causes complete polymerization with creation of a stable, compact material, with the elimination of many negative properties of acrylic like the coefficient of absorption [6]. Graphene polymer has very high flexural strength, esthetics, high superficial abrasion resistance, and after its addition, makes acrylic resin an improved material.

2. Graphene, when coated on titanium substrate, the hydrophobic character of graphene film exerted a self-cleaning effect on its surfaces, thereby decreasing the adhesion of microorganisms, which includes S. sanguinis and S. mutans [7]. Additionally, compared to titanium alone, graphene possesses osteogenic property enhancing the expression of osteogenic related genes RUNX2, COL-I, and ALP, boosting osteocalcin gene and protein expression, consequently increasing the deposition of mineralized matrix [7]. It has high flexural strength, so the impact forces on the underlying coated implant are significantly less. Graphene superstructure can act as a shock absorber, preventing high-impact forces from acting on the implant body. The entire prosthesis can also be made in a single framework [6].

CONCLUSION

Currently, Graphene is an exciting material for intense research both in removable prosthodontics and in Implantology. More clinical studies including randomized clinical trials with greater sample sizes and with encouraging results will enable us to understand this material in a real world setting and make it a preferred choice among clinicians.

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