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The Next Generation Dental Material: Graphene & Derivatives

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Editorial

Oral cavity is always in a state of dynamism. A plethora of dental materials have been used in the past and have been in constant contact with the oral cavity. All such materials have been researched upon in depth about the ideal requisites and properties namely physical, mechanical, chemical, biological, optical, thermal etc.

Carbon, being an element present in abundance, always pioneered in the field of science and technology. Carbon & its allotropes have already been studied in depth; but with the incorporation of the 21st century technology i.e. Nanotechnology, extensive research is going on in relation to the nanostructures of carbon i.e. carbon nanomaterials and carbon nanotubes. The main categories of carbon nanostructures include zero, one, two and three-dimensional. Zero-dimension carbon nanostructures include fullerenes, carbon dots and graphene quantum dots. Nanotubes and nanofibers form the One-dimensional carbon nanostructures. Recent introduction to the carbon nanostructures include the Two-dimensional carbon nanostructures. Out of this, Graphene forms a prominent two-dimensional nanostructure. The three-dimensional carbon nanostructures generally include a combination of one and two dimensional-structures.

Graphene forms the thinnest and the strongest material in existence. It is mainly composed of two-dimensional sheets forming a honeycomb-like lattice or hexagonal packed configuration. Graphene can be synthesized by mainly two approaches: top-down and bottom-up. The nanomaterials belonging to the graphene family include ultrathin graphite, few-layer graphene, graphene oxide (GO), reduced graphene oxide (rGO), and graphene nanosheets (GNS). Out of this, graphene oxide forms the most important aspect in the field of dentistry.

Graphene as a material is resistant, extremely lightweight with exceptional electrical and thermal properties, high intrinsic mobility with good optical transparency. Furthermore, the superior antibacterial properties and tissue regenerative capacities of graphene and derivatives have grabbed a lot of attention particularly on the path of researches seeking newer materials for future biomedical applications. Graphene & derivatives had always been popular in various sectors namely industrial, medical, electronics, artificial intelligence, materials-alloys, energy storage devices, optical, physics, mechanical, nanomaterials, and sustainable chemistry. The superior regenerative capacities of graphene oxide made it quite popular in the field of medicine. With the advent of the emerging technologies, the applications of graphene derivatives mainly graphene oxide transpired as a boon in the field of dentistry.

There have been plethora of applications of graphene oxide (GO) in almost all the fields of dental sciences. The regenerative capabilities of GO has made it a wonder dental material to be used as a scaffold for Periodontal Ligament Stem Cells (PDLSCs) and Dentin Pulp Stem Cells (DPSCs) in the field of tissue engineering. Graphene oxide has also been used as a material for surface coating for improving and modifying implant surface characteristics and ultimately improving the osseointegration. The use of GO is not limited to dental implants. The orthopaedic implantology has also enjoyed GO as a wonder material. In Periodontology,

Graphene oxide did wonders in terms of barrier membrane i.e. in terms of Guided Bone Regeneration (GBR) procedure. Graphene oxide has been in the field of restorative dentistry as a filler particle in restorative materials particularly resin and other cements to improve the mechanical characteristics of the restoration. In addition to this, keeping in view the superior antibacterial properties of graphene oxide, it has been used as an inhibitor to the bacterial biofilm formation. The role of GO in tooth bleaching is significant as it retains the bleaching qualities of hydrogen peroxide (H_2O_2). In endodontics, GO has always been incorporated as an endodontic irrigant. Graphene in combination with silver nanoparticles act as an effective antibacterial substance for active disinfection of the root canals. Graphene oxide has also been used as a carrier for therapeutic protein delivery for BMP-2. Even with the multivaried applications of graphene & derivatives, a lot of research is expected in near future. There have been challenges & issues related to the toxicity of graphene derivatives. The researchers have actively plunged in to research the area of this novel biomaterial even in combination with the sensors particularly the biosensors which will actually detect the oral bacteria. Henceforth, it can be rightly said that graphene and its derivatives will definitely prove to be a boon as "The Next Generation Dental Material".