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Abstract

In this report we have studied the graphene and its derivative graphene oxide(GO) along with its property and uses in various tissue engineeringoperations. Graphene and graphene oxide (GO) have attracted tremendous interest in the tissue engineering field, due to their unique properties, such as fascinating mechanical strength and stiffness, excellent electrical conductivity, and surface functionality. Here, we summarize the detailed tissue engineering applications of graphene and GO, and mainly focus on the relationship between their superior properties and final applications. We hope to provide inspiration to explore more biomedical applications of graphene-based materials

Introduction

Graphene is a 2D building element of other allotropes of carbon. It is a layer of sp2 hybridized atoms of carbon in hexagonal lattice. Due to its discovery and several experiments in 2004, graphene was in great demands in the fields of material science at the times. Graphene and its derivative, graphene oxides(GO) due their excellentpropertiessuchashighyoung's modulus,thermal and electrical conductivities, and unique optical properties. The properties of graphene and GO have provided various services in the fields of nonelectric, sensors, super capacitors and for energy storage in the early stages of research.

GO and other graphene based materials came in biomedical used in 2008. GO was introduced in laboratories as an efficient carrier of drugs. After going through a long research and efforts, graphene oxide came along with various applications ranging from drug delivery, to biomaging, to cell growth controls and for tissue engineering and regenerations.

Properties and application in tissue engineering

Graphene derives its extraordinary properties from its chemical structure. Carbon atoms in graphene are sp2 hybridized, combination of one s and two p orbital along with characteristic angle of 120 degree. Each carbon atom uses thesp2 hybrid orbital to form three covalent sigma bonds with adjacent carbon atoms. The planar structure of graphene provides it huge surface area of approx 2630 m2/g and strong bond of C-C bonds gives great mechanical strength to graphene with Young's modulus of 1100 GPa and a fracture strength of 130 GPa.

Electronic configuration of graphene also enables further chemical modification. The highly dense π electrons on the graphene plane can interact with many bimolecules containing aromatic structures through π_π stacking. They are also suitable for electrophilic reactions such as click reactions, cycloadditions, and carbine insertion reactions. Thus, graphene and GO can be easily be added with several bioactive substances to get desired characteristics that can meet the requirements of tissue engineering.

These sections summarizes and discusses graphene and GO applications in the tissue engineering field based on their mechanical, electrical, chemical, and other properties.

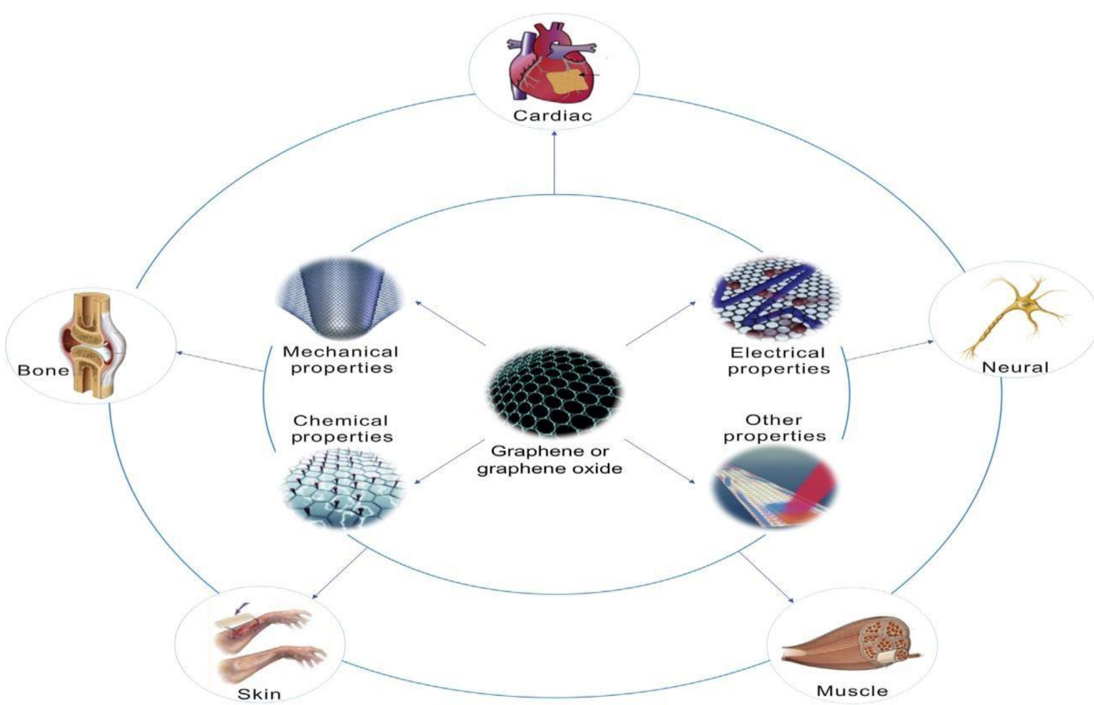

Figure representing the applications of graphene and GO in tissue engineering

Mechanical properties and applications

The amazing mechanical property of graphene and GO can be used to prepare graphene based substances with enhanced mechanical strength for tissue engineering applications. Bioceramics, hydrogels, films, fibers, and many other tissue engineering scaffolds can be greatly improved in mechanical properties and stability by using graphene and GO as reinforcement materials and, thus, canbe applied in various tissue engineering fields. Biomaterials made up of GO are widely used in bone tissue engineering.

Along with mechanical strength enhancement, graphene can also improve the toughness of hybrid materials for load-bearing implant applications to regenerate bone tissue. The toughening property of bone can be enhanced using graphene based composites. The strong interaction between graphene or GO and matrix materials can bridge cracks and impede crack propagation, resulting in enhanced toughness.

The mechanical enhancement of skin and muscle is another major contributionof graphene based substances in tissue engineering.

Electrical properties and application

The conductive nature of graphene and its derivatives is good for various biohybrids that can may be used for signals in tissue engineering applications. Due to electrical characteristics of neural system, graphene plays an importantrole in neural tissue engineering.

Cardiac tissues are electrically conductive, and the graphene-based substances are electrically conductive thus it can match the conductive properties of cardiac tissues or provide electrical stimulation for cardiac repair, thus they serves in the cardiac tissue engineering field and has several applications.

Chemical properties and applications

The large surface area of graphene allows chemical compound and biological species t to interact and allows loading via covalent bonds in various tissue engineering operations. Both functionalized and unmodified graphene and GOcan augment stem cell osteogenesis for bone tissue applications.

Chemical properties of graphene based materials are also useful in neural engineering. In research they demonstrated that by the use of graphene oxide the adsorption of protein and other essential minerals had increased.

Various chemicals present in graphene oxides are utilized in cardiac repairs.

Other properties of graphene oxides

In addition to the above three dominant properties, other unique properties of graphene based materials, including surface morphology, impermeability, and photothermal effects, make them suitable for some specific applications in the tissue engineering field.

The presence of wrinkles and ripped structure of graphene based substanceshelps in increasing the roughness of surface, facilitating strong absorption ofproteins and other essential minerals which helps in cell growth and differentiation.

The graphene coating could enhance the biocompatibility of implant materialsand other biomedical devices used in tissue engineering.

Conclusion

In this report we have studied the various properties and uses of graphene and graphene oxide. Due 2D structure of graphene it has amazing mechanical, electrical and chemical properties, and many more intrinsic properties such as rough morphology and photothermal effects. These excellent properties render graphene and GO to be extensively applied in the field of tissue engineering. Herewe have summarized the application of GO in skin, cardiac, bone, neural and various other biomedical operations.

References

- Sciencedirect.com
- Wikipedia
- thno.org
- YouTube video