# Graphene Oxide: A Novel Approach to Wound Healing

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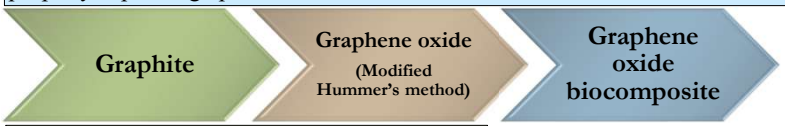
**ABSTRACT**

In diabetic patients delayed wound healing and chronic wounds are major complications that have been a reason for serious concern. As reported in the literature, the underlying causes for such wounds are due to reduction of proliferation and migration of different cells like keratinocytes and fibroblasts. Therefore, there is a high demand to bring a wound dressing patch which could provide the advantages of ideal dressings with gaseous exchange, absorption of wound exudate along with release of incorporated therapeutic at sustained action which could support cell proliferation and migration. Such dressing environment ultimately can assist diabetic wound healing. Due to their excellent biocompatibility, effective cell penetration, high fluorescence and specific adsorption of nucleotides, graphene oxide (GO)-derivatives have been identified in a wide range of biomedical applications. The two main methods for producing GO-based wound dressings are solvent blending method and in-situ polymerization. Several *in-vitro* and *in-vivo* study reports indicated that application of graphene oxide and its reduced form could promote wound healing by the enhancement of migration and proliferation of keratinocytes. Simultaneously, GO has also shown its potential to induce angiogenic properties that have an active role in any inflammatory event.

**Keywords:** graphene oxide; reduced graphene oxide; hydrogel; biocompatibility.

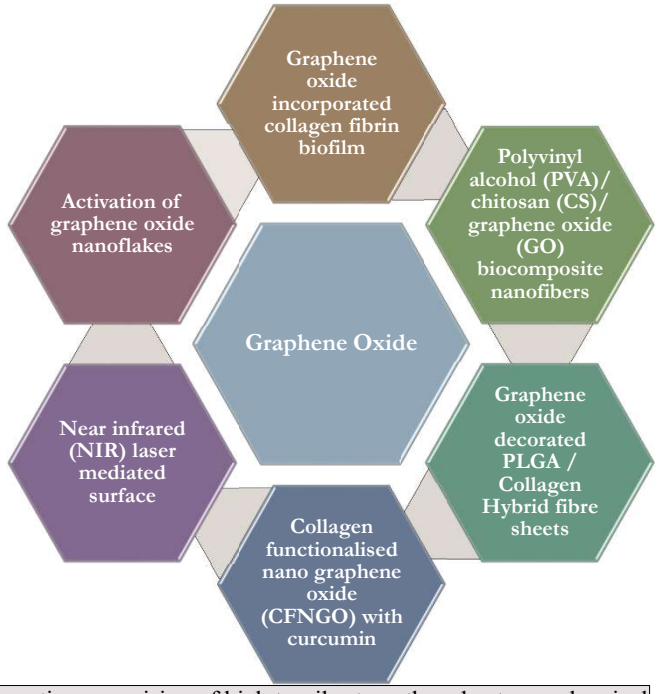
## INTRODUCTION

Delayed healing or non-healing of wounds in case of DFUs is due to multiple factors including the reduction of growth factors and cell proliferation, which leads to reduced peripheral blood flow and decreased angiogenesis. Recently, Graphene and Graphene oxide (GO) have attracted great interests in biomedical applications due to its potential to enhance angiogenesis in wound healing applications.[1] It has been observed the angiogenic property of graphene oxide (GO) and reduced graphene oxide (rGO) through several invitroand in-vivo angiogenesis assays. It was found that GO and rGO exhibit pre-angiogenic property depending upon their concentrations[2].




## GRAPHENE OXIDE COMPOSITES

Poly(vinyl alcohol)/chitosan/graphene oxide biocomposite nanofibers (PVA/CS/GO) could be a promising tissue engineering wound healing material[3]. Chitosan (CS) had used as biomaterial alone in bone regeneration but met with limited success therefore Chitosan (CS), gelatin (Gn) and graphene oxide (GO) scaffolds were designed as improved version in bone regeneration. Hybrid hydrogel membranes composed of reduced graphene oxide (rGO) nanosheets and a poly (vinyl alcohol) (PVA) matrix would be a promising future in biological applications, such as transdermal therapy and wound healing[4]. Preparation of collagen-fibrin biofilm with the help of graphene oxide proved to be promising in healing wound on animal model. Collagen functionalized nano graphene oxide (CFNGO) with induction of drug such as curcumin was evaluated as effective in open wound model[5]. Incorporation of silver with reduced graphene oxide may increase the wound healing effect and prevent infection at same time. A similar work was carried out using silver and reduced graphene oxide in the presence of silver chloride and was found to be effective in burn wound model. Preparation of near infrared (NIR) laser mediated surface activation of graphene oxide nanoflake was found as effective wound healing agent[6].




## CONCLUSION

Graphene is a carbon crystalline hexagonal lattice with amazing physical and chemical properties comprising of high tensile strength and extreme chemical stability. It is used in different form to improve the wound healing, enhancing the rate of wound contraction and reducing scar formation. Toxicological studies on biomaterial such as dermal toxicity, carcinogenic toxicity, allergenicity, genotoxicity is yet to be performed in most of discussed graphene based nanomaterial.

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