Wound care and smart bandage technology based on Graphene monolayers

Vincent Bouchiat[1],

[1]GRAPHEAL, 38042 GRENOBLE Cedex 09 France

Contact vbouchiat@grapheal.fr

After a decade and thousands of publications, graphene produced by CVD on copper foils remains at the sweet spot for quality and cost-effective production of large size, high-mobility graphene transferred on insulators. Use of these monolayers has been so far scarce in industrial applications. I will present the use of this technology for biological (1) and medical applications from both the academic and industrial point of view.

We have first explored the use of graphene-on -polymer for biosensing and tissue engineering. I will show results of in-vitro cellular growth (neurons and skin fibroblasts) on graphene-covered substrate which shows the stimulation of growth (2) and migration of cells promoted by the graphene substrate together with the possibility of probing their electrical activity down to the sub-cellular scale (3).

We are also developing a novel technology platform that exploits the features of monolayer graphene, for woundcare. The first-generation of our system is a graphene-based scaffold that looks like a very thin, transparent plaster. Based on that material, we are building an innovative bandage technology platform based on graphene-on -insulator film in order to better support chronic wounds.

In particular, I will insist on the possibility to combine therapeutics (bio electrostimulation & healing) with diagnostics (biosensing) features in the same device. Following these properties, we have elaborated a graphene-based scaffold that looks like a very thin, transparent plaster integrated in commercial bandage that is indented to be applied in direct contact with an open wound. We believe these films will have some impact in healthcare, as they target some important and poorly addressed diseases such as pressure ulcers and diabetic foot ulcers I will present the preclinical results on animal studies and the perspectives of their commercial (3) use for wound-care, in particular in the treatment and diagnostics of chronic wounds that affect the diabetics and elderly.

Our bandage platform (4) is based on the integration of a monolayer graphene polycrystalline layer back-bonded onto a biocompatible polymer layer (figure 1° . The resulting film can directly be applied onto the bed-wound and is inserted in a commercial bandage. Graphene surface combines healing (speed-up of wound closure) and antibacterial action, optical transparency and electrical conductivity. It is obtained by integrating a large uniform graphene monolayer into a bandage in order to provide a bio- stimulating and electrically-active platform directly applied in contact with the wound. It allows the development of a range of intelligent dressings that combine on the same product both therapeutic and diagnostic actions. -Therapeutic action: graphene functions as a growth matrix, promoting healing but at the same time acting as an electrode in close contact with the wound. This allows the application of electrical pulses whose actions promote faster healing and reduce pain.
-Diagnostic action: Graphene it plays at the same time the role of a biosensor to monitor the wound evolution and early stage detection of infection by pH and biomarker sensing.

References

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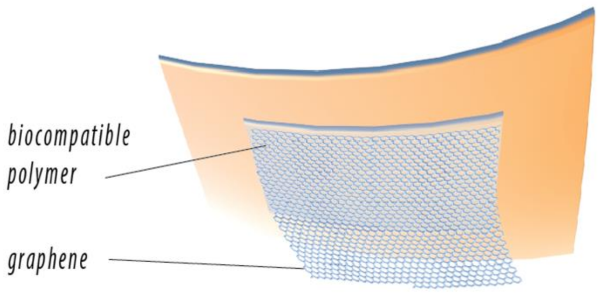

Figure 1. Principle of the graphene-coated bandage platform: a single monolayer of polycristalline, CVD Graphene is assembled onto a biocompatible polymer and integrated in a bandage.