Tunable Release of Ions from Graphene Oxide Laminates for Sustained Antibacterial Activity in a Biomimetic Environment

Kun Huang, Swathi Suran, Negin Kamyar, Farzad Foroutan, Premlal Balakrishna Pillai, Xuzhao Liu, John Vaughan, Darren Wilson, Philip J. Day, Rahul R. Nair
National Graphene Institute, Booth Street East, Manchester, United Kingdom
kun.huang-4@manchester.ac.uk

Abstract

Silver has long been recognized for its potent antimicrobial properties, but achieving a slow and longer-term delivery of silver ions presents significant challenges. Previous efforts to control silver ion dosages have struggled to sustain release for extended periods in biomimetic environments, especially in the presence of complex proteins. This challenge is underscored by the absence of technology for sustaining antimicrobial activity, especially in the context of orthopedic implants where long-term efficacy, extending beyond 7 days, is essential. In this study, the tunable, slow, and longer-term release of silver ions from the two-dimensional (2D) nanocapillaries of graphene oxide (GO) laminates incorporated with silver ions (Ag-GO) for antimicrobial applications are successfully demonstrated. To closely mimic a physiologically relevant serum-based environment, a novel in vitro study model using 100% fetal bovine serum (FBS) is introduced as the test medium for microbiology, biocompatibility, and bioactivity studies. To emulate fluid circulation in a physiological environment, the in vitro studies are challenged with serum exchange protocols on different days. The findings show that the Ag-GO coating can sustainably release silver ions at a minimum dosage of 10 µg cm−2 day−1, providing an effective and sustained antimicrobial barrier for over ten days.

References

[1] Suran, S., Kamyar, N., Huang, K., Foroutan, F., Balakrishna Pillai, P., Liu, X., Vaughan, J., Wilson, D., Day, P.J. and Nair, R.R., 2024. Tunable Release of Ions from Graphene Oxide Laminates for Sustained Antibacterial Activity in a Biomimetic Environment. Small, p.2304850.

Figures

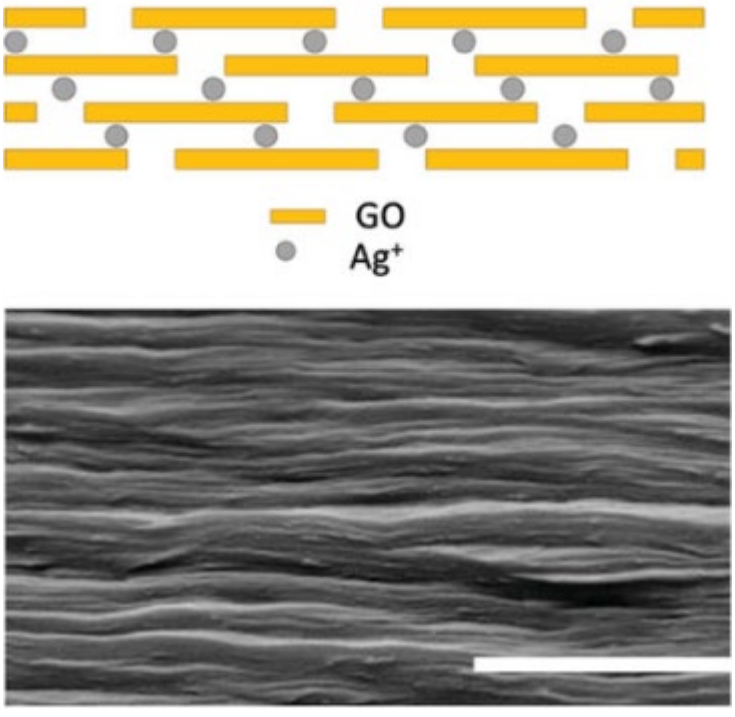

Figure 1: Schematic showing Ag^+ ions incorporated in the interlayer spacing of GO laminate