Simple and versatile non-covalent functionalization protocol turning graphene bacteriophilic, bacteriostatic or bactericidal

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In this study, we present the first evidence of a tailorable functionalization of monolayer graphene basal plane using tripodal pyrene based compound (tripod) **[1]** compound and a stoichiometric mix of bacteria binding immunoglobulins (IgG) and antimicrobial peptide cecropin A. The specific functionalization of the graphene surface with tripod avoid simple adsorption of bioreceptors onto graphene surface as it has been demonstrated to irreversibly denature protein bioreceptors **[2]**. Tripod is used for bioconjugation, which is based on a design to functionalize monolayer Graphene. It incorporates a multivalent design in which three pyrene–SLG interactions provide extraordinary SAM stability in both aqueous and organic solvents. Antibodies have been used for their selective analytic binding specificity. In our case anti-*E.coli* antibody (aEAB) bioconjugated on the graphene surface capture bacteria on the graphene surface. Antimicrobial peptide (AMPE) cecropin A used in this work is known to induce cellular death by damaging the outer membrane of bacteria cells. Thus, graphene functionalized with a mix of 50% aEAB and 50% AMPE not only capture (Figure 1) but restrict any cellular division (Figure 2). By changing the ratio of antibodies and AMPE in the functionalization mix we thus report to be able to give three distinctive behavior towards bacteria landing of graphene. We achieved bacteriophilic graphene surface where bacteria attach and form a solidly grafted biofilm via exponential growth, we achieved bacteriostatic graphene where bacteria are bound, remain viable but cannot engage cellular division and finally we achieved bactericidal graphene where any bound bacteria is being killed. Such a versatile, easy to implement and non covalent functionalization protocol with such various effects is still unheard of at his point to the author's best knowledge.

References

[1] J. A. Mann et al., Angew. Chem. Int. Ed. 11 (2013) 3177.
[2] T. Alava et al., Anal. Chem. 5 (2013) 2754.

Figures

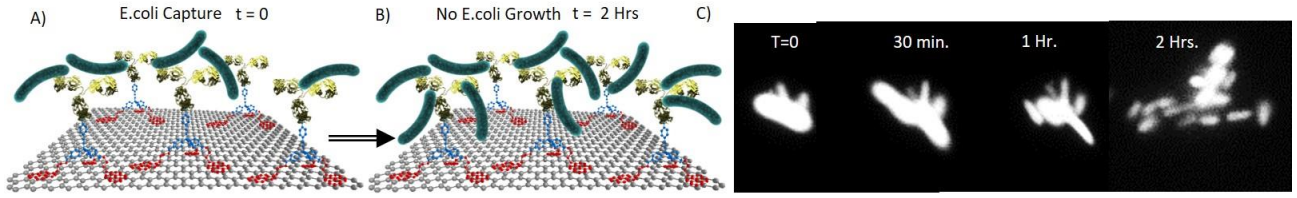

Figure 1A: (Left) Shows schematic of *E.coli* cells captured (T=0) and **Figure 1B:** (Centre) cellular division over the functionalized graphene surface with 100% aEAB bioconjugation (T = 2 Hrs.). **Figure 1C:** (Right) Optical images of captured *E.coli* cells and cellular divisions on functionalized graphene surface with time.

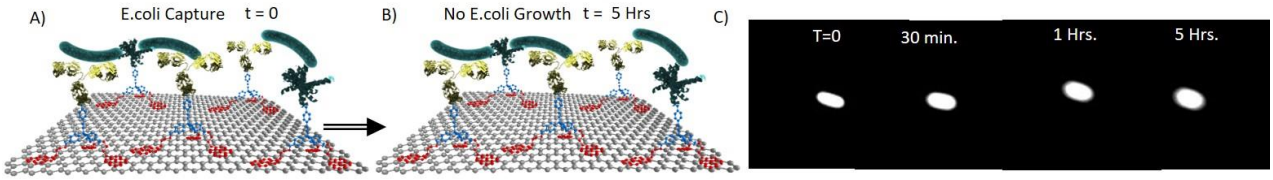

Figure 2A: (Left) Shows schematic of *E.coli* cell captured (T=0) **Figure 2B:** (Centre) No cellular divisions (t = 5 Hrs.) over the functionalized graphene surface with 50% aEAB and 50% AMPE bioconjugation. **Figure 2C:** (Right) Optical images of captured single *E.coli cell* but no cellular division on functionalized graphene surface with time.