Models for Simulation Based Selection of 3D Multilayered Graphene Biosensors
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Introduction: Through COMSOL Multiphysics modeling and simulation were identified the best fitted solutions for a multilayered biosensing device structure from the presently known graphene (and composite materials including different forms of graphene).

Computational Methods: All these models are having the same continuum-like background of a biosensor device structure based on weak van der Waals interaction forces that describe the nonlinear behavior of graphene into a surrounding viscoelastic environment through classical Kirchhoff plate theory

\[ D \nabla^4 w + \alpha_1 w + \alpha_3 w^3 + \rho h \frac{\partial^2 w}{\partial x^2} + N_x \frac{\partial^2 w}{\partial x^2} + N_y \frac{\partial^2 w}{\partial y^2} = 0 \]  

where: \( N_x, N_y \) are biaxial in-plane loads; \( a, b \) - length, width of graphene; \( h \) - thickness of graphene; \( \rho \) – distributed transverse load per unit area (due to surrounding medium effect); \( D \) is the bending stiffness of the plate:

\[ D = \frac{E h^3}{12(1-\nu^2)} \]  

for all models were studied the charge density distributions of electric, thermal and acoustic field stimuli responsible for \((\varepsilon - \phi), \) \((\rho - \phi)\) and \((\text{ion} - \phi)\) interactions.

Results: A large number of device module types have been tested in order to define the best response of the hydrogel- polymer layer (PVA Hydrogel) on the graphene sheets and of the protein functionalized graphene biosensors.

Conclusions: For each module type the graphene/ graphene composite materials generate clearly differentiate responses to the environmental stimuli, or process microvariables evolution, thus confirming the biosensing ability of this class of materials.

References:
B. Hille, Ion Channels of Excitable Membranes, Sinauer, (2001)
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