SIMULATION AND DESIGN OF NONLINEAR MATERIAL STRUCTURES FOR ENERGY AND BIOMEDICAL DEVICES

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Introduction. The project's main objective is the development of mathematical models and solutions of the models for simulation and design of some modern nonlinear material structures for energy and biomedical devices. One of the challenges in modeling the structural behavior of the materials is that they cannot be modeled accurately by the theory of linear elasticity or common linearization theory even at small strains for not having a well-defined yield stress point.

Materials and methods. A conceptual framework was developed for modeling and simulation of nonlinear material structure elements in the following table:

Materials:	Graphene, Polyimide, High Strength Alloys
Devices:	MEMS/NAMS Pressure Sensors, Actuators, Resonators, Neuro-Probes, Switches
Background Theory:	Continuum Mechanics, Nonlinear Constitutive Equations
Software:	Matlab, Mathematica, Comsol, Abaqus, Ansys
Simulation methods:	Symbolic and Numerical Computations; Perturbation Methods;
Finite Difference and Finite Element Methods;	Nonlinear Optimization

Results and discussion. Several initial results are reported in [1¬ 3] for simulation of buckling and deflection of graphene beam and polyimide beams and tubes. One example of our new results is the critical buckling pressure for a graphene tube: ° R^3 ^*Rla*^ and the post-buckling shapes (Figure 1) of the cross-section of the tube.

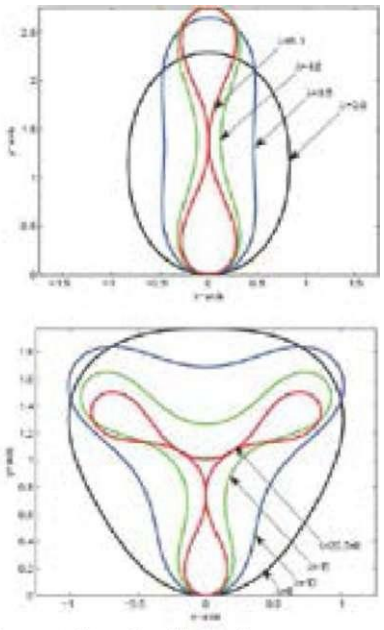

Figure 1. Post-buckling shapes

Conclusions. The initial results and proposed research project will provide more efficient design guide and software for a variety of structural devices made of modern materials by shortening the design cycle and providing more accurate assessment of the mechanical behavior of the devices, and ultimately speeding up the pass of these new materials into making devices for real life applications in advanced energy storage, semi-conductor, and medical industries.

References.

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