**Dynamic Characteristics of Dielectric Polymer Beams Reinforced with Graphene Platelets (GPLs)**

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**Abstract:**

Due to graphene and its derivatives’ excellent mechanical, thermal and electrical properties, they have demonstrated great potential as reinforcements in polymers for various engineering applications [1]. Apart from graphene and its derivatives’ reinforcing effects on mechanical properties [2], the electrical properties of the composites, i.e. dielectric permittivity, can be remarkably improved [3]. Compared to structures with traditional materials, the mechanical behaviours of such polymer composite based structures can be actively tuned by adjusting the pre-stretching strain, amplitude and frequency of the applied electric field. Numerous works have been found on studying the mechanical properties and structural behaviours of graphene and its derivatives reinforced composite materials and structures [4]. However, relatively less work has been carried out on analysing graphene reinforced polymer composite beams while considering the dielectric properties of the composite materials. In present work, graphene’s derivative, graphene platelet (GPL) is used as reinforcement in polymers. The mechanical properties, i.e. Young’s modulus and Poisson’s ratio, are determined by modified Halpin-Tsai model and rule of mixture, respectively. The electrical permittivity of the composite materials is obtained by applying effective medium theory with considering the interface between GPL and the polymer matrix. Pre-stretching and electrical field are applied on the composite beams, which can be used to alter the rigidity of the structures. Based on Timoshenko beam theory, theoretical formulation for the dynamic behaviours of the structures is derived and solved numerically. Comprehensive parametric study is conducted to investigate the effects of the concentration and size of GPLs, and the amplitude and frequency of the applied electric field on the dynamic characteristics of the structures. The results demonstrate the dynamic performance of the structures can be actively tuned by changing the amplitude and frequency of the applied voltage. The applied voltage with larger amplitude is preferred for active tuning of the composite structures. However, higher voltage may increase the risk of failure due to electric breakdown of the composite materials. The results also indicate that lower frequency is beneficial for higher dielectric permittivity, resulting in better capability of active tuning for the structures. The analysis in present work is envisaged to provide guidelines for the design and optimization of GPL reinforced polymer composite structures with dielectric properties.

**References**

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