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Active vibration control of smart structures bonded with discrete piezoelectric sensors and actuators located optimally using a reduced genetic algorithm

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Demand for the development of mechanical structures with high specific strength has increased among industrial companies to build lightweight aerospace structures, tall buildings and long bridges. The objectives of the construction of such structures are to optimize loading capacity, energy consumption and material costs. However, these structures are associated with complicated vibration problems. Traditionally, vibration has been reduced passively by adding mass, damping and stiffness. However, this method leads to increased weight, low response and sensing to low vibration energy. The alternative is active vibration control, in which vibration is measured using sensors and opposed by forces generated by actuators, with a control system linking the two. Piezoelectric sensors and actuators have been investigated in terms of their size, number and location on structures to optimize vibration attenuation. Arbitrarily placing discrete sensors and actuators on a structure leads to weak vibration suppression, whereas more suitable placement using optimization methods such as genetic algorithms can give very effective results. However, for a small structure discretized to one hundred elements optimized for ten sensor/actuator pairs gives 1.73×(10)^13 candidate solutions with many local optima but only one global optimal solution. This research has proven that the optimal distribution for symmetrical dynamic stiffened and unstiffened structures is also symmetric. This symmetry is exploited in genetic algorithm placement strategy by a development of half and quarter chromosomes which reduce the optimization problem by more than 99%. This reduction gives high impact by solving large smart structures to find the global optimal configuration of discrete piezoelectric sensors and actuators with high computational efficiency.

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Chemical functionalization of CVD graphene films

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In recent years, the new material graphene is at the center of synthesis of free standing two-dimensional nanostructures that provide a development of new technologies. The progress in the development of graphene devices is future promising and they are now considered as an option for the current Si-based electronics because of its unique properties. The most promising characteristic of graphene is its ability to be further functionalized based on the desired way. Although there are well-established methods to further functionalize the graphene sheets such as introducing a dopant atom or different level of defect structures, here we introduce a new and convenient way to change the properties of graphene by using different polymers which interact with CVD graphene during the transfer process. Additionally, Raman Spectroscopy is used for characterization of large area single layer graphene. By monitoring the variations of the wavenumber in G and 2D, we extract the doping properties in the graphene layer which shows different characteristics for different type of polymers.

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