

Influence of quality factor on the dynamics of single walled carbon nanotube based mass sensor

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Nonlinear dynamic behaviour of a wavy single-walled carbon nanotube is analyzed in context of Quality Factor and Damping. The equation of motion involves two types of nonlinearities arising mainly due to the curved geometry and due to the bridged boundary conditions

From an elastic continuum viewpoint, a carbon nanotube can be described as a beam with an annular cross section having a large aspect ratio. The nano beam is considered to be doubly clamped and has a sinusoidal curvature with a small rise function described by

$$Z = \Delta \sin\left(\frac{\pi x}{L}\right)$$

where x is the spatial coordinate, L is length of the carbon nanotube, and 'Δ' is the amplitude of its waviness. Applying the Energy and Galerkin approach along with the introduction of damping factor to study the dynamic behavior of SWCNT under condition of primary resonance, the equation of motion of a doubly clamped wavy CNT is obtained as

$$(1 + M)\ddot{\theta} + 2\zeta\dot{\theta} + \theta + \frac{\beta r}{\alpha}\theta^2 + \frac{\varepsilon r^2}{\alpha}\theta^3 = \frac{f}{r\alpha}\cos(\omega t)$$

The variation in the quality factor of the system is studied in context of the dynamic tools like Time Response, Poincare Maps and Phase plane diagrams. The variation in the Quality factor is taken as 1 to 4 for fixed length, diameter, thickness and mass attached to the CNT. Loss of periodicity is clearly seen with the increase in the Quality factor which is a well known characteristic of chaotic response. The response shows the clear transformation from chaotic to periodic and vice versa with variation of the quality factor and hence damping. Hence, along with the mass, CNT is also found sensitive to the surface deviation and the Quality factor.

Biography

Anand Y Joshi has completed his Ph.D at the age of 34 years from Indian Institute of Technology Roorkee, India. He is currently working as a Professor in Mechatronics Engineering at G.H.Patel College of Engg & Tech., Vallabh Vidyanagar, Gujarat, India. He has published more than 15 papers in reputed journals and serving as an editorial board member and invited reviewer in a number of journals of repute.

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