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Instabilities of Composite Materials Reinforced by Nano-Fibres: a Re-examination of Elastic Buckling

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Elastic instability of composites reinforced by nano-fibres is investigated. Such composites are necessarily dilute and when reinforced by fibres of exceedingly high stiffness (such as carbon nanotubes) may, in fact, buckle elastically. As opposed to the classical solution given by Rosen, where instability is found to occur either in a shear mode with an infinite wave length or in a transverse mode, it is shown analytically that buckling can occur only in the shear mode with finite wave length and that the transverse mode is spurious. The shear buckling is shown to exist under two régimes with buckling of dilute composites occurring with finite wavelengths. Based on the analysis, a model is constructed which defines the fiber concentration at which the transition between the two régimes occurs. For the case of dilute composites which is the case of interest of nano-fibre reinforced composites, the solution differs markedly with the Rosen solution. The buckling strains for dilute composites are shown to have realistic values compatible with elastic behavior. The investigation demonstrates that elastic buckling may thus be a dominant failure mechanism of composites consisting of very stiff fibers fabricated in the framework of nanotechnology.

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