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Complete CNT disentanglement–dispersion–functionalisation in a pulsating micro-structured reactor

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HIGHLIGHTS

- CNT disentanglement–dispersion–distribution is fully attained by a micro-reactor.
- Also, functionalisation, leading to homogenised reinforcement, is complete.
- Disentanglement–functionalisation are attained with negligible CNT attrition.
- The reactor generates an extensional-shear-spiralling flow and is easy up-scalable.

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ABSTRACT

Disentanglement, dispersion of CNTs without attrition and efficient interfacial interaction with polymer chains are a major challenge in developing CNT/polymer composites. In the present device the mixture of highly viscous polyphosphoric acid (PPA) and entangled MWCNTs fills a hollow cylinder where a perforated piston, encasing micro-grids, is axially translating, oscillating and simultaneously rotating. This generates an extensional-shear-spiralling flow, magnified in the entrance/exit zone of the grid micro-openings, the smallest having diameter of 40 μm. The reciprocating action forces the agglomerates to cross the grid many times, while the oscillation reduces effectively the clogging of the grid. Flow micro-splitting and recombination, across millions of micro-openings in a time dependent regime, facilitated erosion and collision mechanisms to prevail, leading to a gradual CNT deagglomeration–dispersion without CNT attrition. The resulting high multi-directional-rotational flow generated the conditions for efficient functionalisation.

Fig. 4. The reactor.

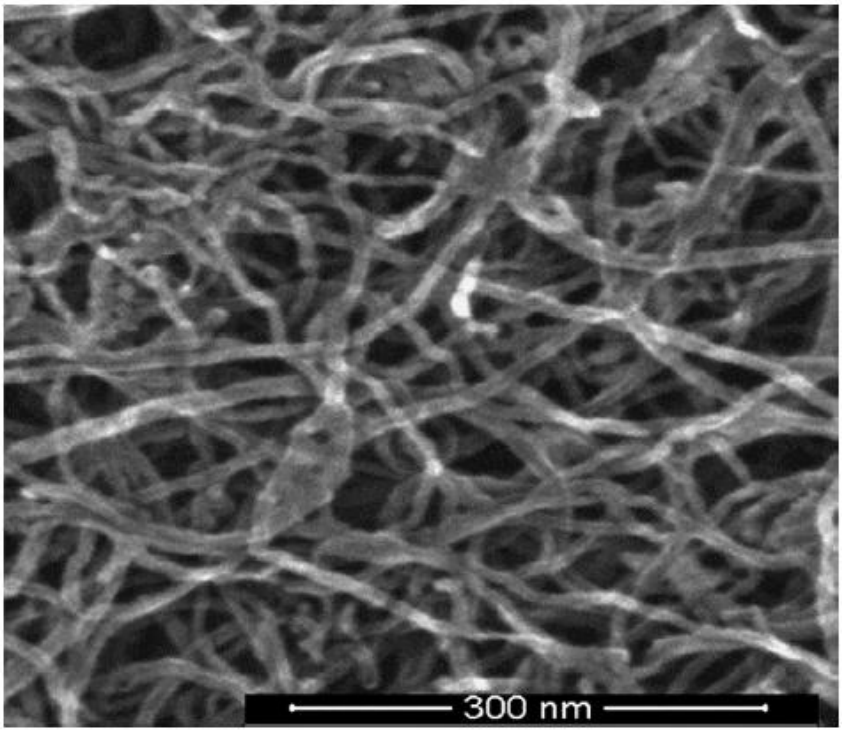

Fig. 7. Disentangled CNTs.