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INVESTIGATION OF A HYBRID MIXING SYSTEM FOR LIQUID-BASED PROCESSING OF NANOCOMPOSITE MATERIALS

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The reinforcement of a base material consisting of either metals, polymers, or ceramics with nanomaterials provides a pathway toward achieving enhancement of the mechanical and physical properties of the base matrix material. However, the high surface area-to-volume ratios, and high surface energies of nanomaterials pose several challenges with achieving their uniform dispersion and distribution in the matrix. In the case of liquid-based processing of nanocomposite materials, mechanical mixing and ultrasonic processing are two different physical processes that are widely used for mixing of nanomaterials in a liquid medium such as molten metals and polymer solutions. The acoustic cavitation effect generated during ultrasonic processing is highly advantageous in breaking apart aggregates or clusters of nanomaterials in a liquid, but the extent of this effect is confined within a limited volume of liquid adjacent to the source of the ultrasound energy. On the other hand, mechanical mixing aided by agitation of a liquid medium using rotary impellers can achieve flow circulation in much larger volumes of liquids; but the low shear forces are not sufficient to overcome the inter-particle attraction of nanomaterials. In this talk, I will discuss my investigations on studying the influence of the geometrical configuration of the mixing vessel and impeller on the fluid flow characteristics involved in mechanical mixing. This computational model is intended to assist in the future development of a hybrid mixing system, in order to achieve mechanical mixing-assisted circulation of cavitation bubbles within the entire liquid volume, thereby providing a pathway toward overcoming the volume constraint of ultrasonic processing. This research provides a route towards overcoming the scientific and engineering challenges associated with scaling up the manufacturing of lightweight, high performance nanocomposite materials to sufficiently large quantities for use in practical industrial applications.

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