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Investigation of Particulate Motion in Pure Shearing Polymeric Fluids

The undergraduate student supported as part of this proposed research will fabricate an in-situ imaging capability to capture the motion of individual fibers suspended in a fluid within a parallel plate rheometer. This successful completion of this work by the Mechanical Engineering student will serve to create the preliminary results for future studies on the model validation of the investigator's constitutive models for short- and long-fiber motion within a polymer melt. The scope of the project falls within the PI's multi-year objective to construct physics-based constitutive models to represent the full coupling between fiber orientation kinematics and fluid kinetics, and to quantify the appropriate criteria for model simplifications of the constitutive equations of motion that will balance accuracy with computational feasibility. The results from the proposed URSA project will provide the preliminary results for an anticipated submission in October of 2011 to the Materials Processing and Manufacturing program within the Engineering directorate of the National Science Foundation.

The demand for lightweight, durable, composites has been the focus of industrial research for many years. The successful representation of the underlying fiber microstructure proposed within this URSA is a key component to the long-term objective of providing the design engineer a means to predict the structural response of industrial composites with synthetic and natural fibers, and develop appropriate products that can utilize these flexible fibers.

The educational impacts on the undergraduate student researcher will be observed and refined as the student learns the importance of computational modeling as an engineering tool, along with the importance of experimental validation for any theoretical application. The long term research impact from this project will be the fabricated imaging device and imaging software suite which will be used for further research within the PI's research program. There will also be a long-term educational impact within the investigator's finite element methods and numerical methods course sequences where students will be provided direct access to the developed data as part of various course projects.