INTEGRATING EXPERIMENTATION, MODELING, AND VISUALIZATION THROUGH FULL-FIELD METHODS

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Evaluation and calibration of sophisticated, physics-based models of material behavior are hampered by the relative paucity of data that is available through traditional test techniques. The quantity of information acquired from traditional techniques may be sufficient for the simplest models, but physics-based models, which attempt to describe material behavior through understanding of the effect of material structure at many size scales, require a much greater amount of data. There are generally many degrees of freedom in these models, especially in multi-scale, nonlinear models, and the much greater amount of data is required to efficiently evaluate and calibrate these models. This leads to fully *verified* modeling and simulation, leading to, in turn, much enhanced fundamental understanding of material behavior. In addition, advanced visualization methods are vital in understanding complex, three-dimensional material structure and behavior.

Modern, full-field experimental techniques offer great promise in efficiently acquiring these large amounts of data. This can be accomplished at various size scales, and the resulting information is vital in calibrating and evaluating advanced models of general, nonlinear, material behavior. In addition to the further development of full-field experimental techniques, the tools that enable correlation between results from experiments and from models are relatively unsophisticated and need much greater development.

Recent research, conducted at AFRL/ML and in which full-field techniques were used, will be presented. This work represents a broad spectrum of materials-behavior research, including contact problems, simple tension, fatigue-crack growth, and microstructural deformation. In this last, the nonlinear, full-field strain resulting from the heterogeneity of the material's microstructure can be studied, enabling the evaluation and calibration of advanced microstructural-deformation models to much greater extent than previously possible.

Finally, the potential application of such experimental techniques to new material systems, such as carbon foams, will be discussed, along with the close integration of this work with modeling and visualization efforts.

Key words: deformation, microstructure, nanostructure