

## Research Statement

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I have been a researcher in the field of quantitative nondestructive evaluation (QNDE) for over ten years now. The essential idea behind QNDE is that, through careful experimental practice and a thorough understanding of the physical problem, measurements can be interpreted with greater accuracy. Although nondestructive evaluation is and will continue to be a strong area of interest for me, my research extends past this discipline into many related fields including i) sensors, embedded sensors and sensor networks, ii) advanced manufacturing techniques including direct deposition of nano-particle dispersions for high density interconnects, wire bond replacement in VLSI packaging and miniature sensor fabrication, and iii) measurement, characterization and application of magnetic materials.

In the field of nondestructive evaluation, there are a couple of areas of research that I believe will become increasingly important over the next decade or so. Firstly, new manufacturing techniques that involve directly depositing material using techniques similar to those employed in an ink-jet printer offer the potential to miniaturize sensors, enhance sensor performance and reduce manufacturing costs. I have been looking into these techniques (I have a patent application and an invention disclosure on the subject) for the manufacture of miniature eddy-current coils. But the technology of direct write has almost limitless possibilities for research and industrial applications. My primary academic research goal will be to develop a direct-write capability at ISU through the acquisition of equipment from Optomec, Inc. With such equipment in place it will be possible to explore other areas such as wireless sensors and sensor networks and *in-situ* or embedded sensors. These areas have recently featured prominently in both military and civil proposal solicitations. I will explore internal funding opportunities such as Carver grants and external sources from agencies such as the National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA) for the procurement of direct-write equipment. It is often important to include multi-disciplinary components when writing proposals; Optomec's direct-write equipment is compatible with materials used in many areas of science and engineering making the task of satisfying the multi-disciplinary criteria much easier.

A second important research area relates to the interpretation of electromagnetic nondestructive test data. Measurement systems have become quite advanced over the years with, for example, the evolution of pulsed eddy-current instrumentation that provides a large amount of information pertaining to a given test specimen. Unfortunately, methods for interpreting the results have not kept up. Undoubtedly, model-based inversion will play a significant role in the future analysis of nondestructive test data. However, up until now, the majority of model-based inversion schemes have looked only at artificial cases. I believe it is important to get the model-based methods working in the inspection environment, even if problems of reduced complexity need to be tackled first. I will look specifically towards the NSF for funding this type of research. In particular, I believe the NSF GOALI (Grant Opportunities for Academic Liaison with Industry) will provide a good framework for this research. A GOALI will bring together academic expertise and commercial pragmatism such that research can be directed towards solving practical problems. I will approach my existing industrial contacts in the field of nondestructive evaluation as a first step towards developing a program of this nature.

Finally, I would like to continue work that I first started at ISU in the area of electromagnetic property profiling of hardened steels. The first set of data I published on the electromagnetic profiles observed in induction-hardened steel rods was quite novel and of general interest. There are many directions this work could follow from here including the incorporation of these results into models and the extension of these studies to cover more complex materials such as carburized steels. I believe this work is worthy of future funding by the NSF.