Statement of

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Chairman Nelson, Ranking Member Boozman, and Members of the Committee, Thank you for the privilege and honor to provide testimony today regarding the National Nanotechnology Initiative (NNI). This testimony provides my personal perspective on the issue that is the subject of this hearing, and does not necessarily reflect that of any organizations with which I affiliated.

I am Chad Mirkin, a Professor at Northwestern University and Director of the Northwestern University International Institute for Nanotechnology, one of the largest university nanotechnology centers in the world. I also am a member of the President's Council of Advisors on Science and Technology (PCAST) and contributed to their report titled, "*Report to the President and Congress on the Third Assessment of the National Nanotechnology Initiative.*" In addition, I served as a co-chair on the science policy report committee, coordinated by the World Technology Evaluation Center, which produced "*Nanotechnology Research Directions for Societal Needs in 2020*", an analysis of world accomplishments in nanotechnology during the first ten years of the NNI and an assessment of the prospects for the next ten years. This report had input from leading experts from academia, industry, and government from over 35 countries in forums held in four different countries last year. In addition, I have started three nanotech companies, Nanosphere, NanoInk, and AuraSense, which have commercialized NNI-sponsored university-based inventions, generated hundreds of new jobs, and begun to build a new economic and manufacturing base for the nation. Consequently, I have a fairly broad view of the field and an understanding of some of the issues facing the United States as it tries to maintain a leadership position within it.

The first ten years of the NNI have been an overwhelming success. The visibility and societal importance of nanoscale science, engineering, and technology have been confirmed, while extreme predictions, both pro and con, have receded. The field has been recognized as revolutionary and comparable to the introduction of the biotechnology and digital information revolutions. The worldwide market for products incorporating nanotechnology is significant and reached about a quarter of a trillion dollars in 2009. This is just the "tip of the iceberg", and the US is positioned to make

extraordinary strides over the next ten years. However, the rest of the world now understands the importance of this field, and many countries are building efforts that rival what has been established by the NNI. This includes dozens of institutes throughout China, Japan, Singapore, Taiwan, Saudi Arabia, and many countries in Europe, including Germany, Switzerland, and Great Britain. If the United States does not act now and aggressively pursue the development of nanoscience and nanotechnology, we will lose our position as the global leader in this transformative field; moreover, we will lose the opportunities it can afford us to build our economy and new manufacturing base.

Why is there so much interest in nanotechnology? The reason is simple; it has the potential to transform almost every aspect of our lives by providing rapid routes to addressing some of the most pressing problems in health care, electronics, energy, and the environment. One of the lessons learned over the first ten years is that every material, when miniaturized, has new properties, and many of these properties can be used to create applications and technologies that solve these problems.

Take for example, a technology like gene-regulation --- a few decades ago, this technology held the promise of treating and potentially curing some of the most debilitating diseases, including cardiovascular disease, neurological disorders like Alzheimer's disease, and many forms of cancer. As scientists and doctors, we have learned that it is not an easy technology to implement and requires materials that can deliver the genetic drugs effectively and without toxicity. The fastest way to new materials is through the miniaturization of existing materials (a tenet of nanotechnology). Researchers are now discovering all sorts of nanomaterials (through NNI-funded efforts like the National Cancer Institute's Centers of Cancer Nanotechnology Excellence) that show extraordinary promise for the effective use of such therapies in humans. I am convinced that nanotechnology will play a lead role in finding cures for these diseases.

On the diagnostic side, NNI-funded efforts like the National Science Foundation's Nanoscale Science and Engineering Centers have discovered powerful new ways of detecting and tracking disease markers at very early stages – stages that cannot be

detected with conventional tools and when therapeutics can be more effective. They have created ways of differentiating patient populations to determine which ones will respond to a given therapeutic and which ones will not. This not only improves patient care but also substantially lowers the cost of healthcare, since many costly therapeutics are now often broadly (and needlessly) distributed to the American population, when their effectiveness is in question for a significant portion of it.

In the area of energy, we need new advances in solar energy technologies, batteries, and biofuels. Meaningful advances in these areas have been hampered over the last decade because existing materials do not offer the properties required for a given application. Again, nanotechnology is leading the way to solving these problems. New plants are being built and jobs are being created. Companies like A123 have used nanotechnological approaches to create powerful new batteries that are being built in Michigan and will go into some of the current and future lines of electric cars and commercial vehicles. After only a decade, it is simply remarkable to see basic science already transition into meaningful commercial successes. Innovation and the related job creation will likely continue at an accelerated rate if we maintain a well-coordinated, and implemented NNI.

What are the challenges going forward? Based upon my personal observations and the committee that wrote the world overview report, we should not be discussing the renewal of the NNI but rather its expansion -- a tough but critical decision in troubled economic times. The United States cannot afford to lose its competitive edge in nanotechnology over the next decade, and an expanded, well-coordinated and targeted NNI is the only effective way to accomplish this objective.

There are three primary areas, which need to be addressed, including:

1. Strengthening the NNI management structure,
2. Developing strategies for future investment in both research and education/training, and

3. Dealing with environment, health, and safety (EHS) issues potentially posed by nanotechnology.

I would like to share with you my recommendations in two of these three areas. I will not focus on EHS since we have other experts providing testimony on this topic.

In the management area, the National Nanotechnology Coordination Office (or NNCO) should broaden its impact and efficacy and improve its ability to coordinate and develop NNI programs and policies related to those programs. The OSTP should facilitate these improvements by taking the following actions:

- First, require each agency in the NNI to have senior representatives with decision-making authority participate in coordination activities of the NNI.
- Second, strengthen the NNCO to enhance its ability to act as the coordinating entity for the NNI.
- Third, mandate that the NNCO develop metrics for nanotechnology-specific program outputs and that it work with the Bureau of Economic Analysis to develop meaningful metrics and to collect data on the economic impacts of the NNI. PCAST estimated that 0.3 percent of NNI funding should be dedicated to the NNCO in order to ensure the appropriate staffing and budget to effectively develop, monitor, and assess NNI programs.

With regard to strategies for future investments, the NNI should maintain a parallel focus on basic research and its translation into commercializable products and processes. We cannot have the latter without the former.

With a budget planning process coordinated by OSTP, each agency would continually re-evaluate its NNI balance of investments among the Program Component Areas. Each area should enhance its focus on commercialization and double its investment in nanomanufacturing over the next five years, while maintaining the current level of investment in basic research.

The NNI should have a focus on signature initiatives such as the development of nanomaterials to enable the development of nanomedicine, advanced nanomanufacturing, and nanomaterials for environmental monitoring and remediation. Each Signature Initiative's lead agency should develop coordinated milestones, promote strong educational components, and create public-private partnerships to leverage the outcomes of the Initiatives. Each lead agency also should develop strategies for monitoring, evaluating, and disseminating outcomes. The opportunities in this field are immense, but we need a way to identify and coordinate national centers of excellence that act as international hubs to attract the best and the brightest in the field, and train the next generation of workers and leaders in nanomanufacturing.

In the area of education, the agencies of the NNI should continue making investments in innovative and effective education, and the NNCO should consider commissioning a comprehensive evaluation of the outcomes of the overall investment in NNI education. As products are being commercialized and nanotech industries are being built, we must have a parallel effort in student training and education. These are the folks who will become the workers and leaders in these new companies. I just visited one of our companies, NanoInk, and they are producing products that are very important to the pharmaceutical industry for high throughput drug screening applications. Pharmaceutical companies want to use these tools in-house immediately, but they do not have a competent workforce available to handle them. Universities need to train a new workforce and retrain an old one, so that these positions can be filled with highly qualified individuals at the pace of the nanotechnology industry development. The NNI should play an important role in making this happen for the field at large.

In conclusion, I strongly believe that advances in nanotechnology will continue to play a critical part on the world economic stage and that it is imperative that the U.S. continue to support, strengthen, and expand the NNI in order to maintain its competitive edge. I thank you for your time, attention, and service to the country, and am happy to answer any questions that you may have.