Stress-Induced Fabrication

Physical force induces material phase transitions to form new nanomaterials.

R&D 100 2016 WINNER

Stress-Induced Fabrication (SIF) uses compressive mechanical stress to create new nanomaterials and nanocomposites with lower production costs and enhanced performance compared to current chemical synthesis routes.

A new paradigm for functionally designed nanomaterials

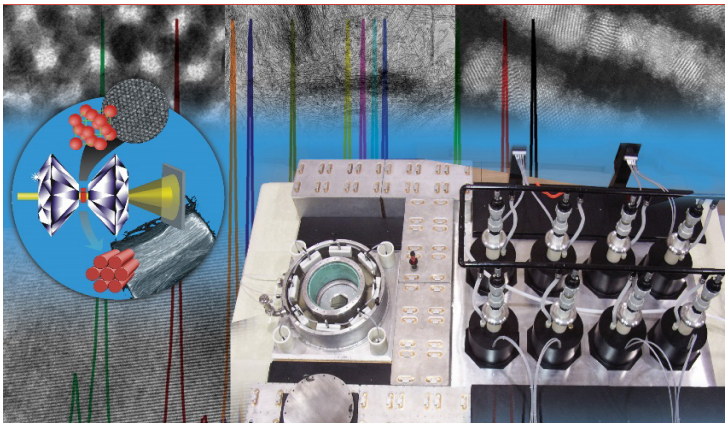
Stress-Induced Fabrication enables the production of new materials with better performance and structure control while reducing costs, improving manufacturability, and minimizing environmental and safety concerns. Sandia's technology represents a new paradigm for the production of functionally designed nanomaterials with more degrees of freedom than chemical methods. It offers significant flexibility in control of materials architecture and property, as well as direct integration of nanoelectronic devices. The cross-disciplinary, economic, logistic, and environmental benefits of these new processes promise widespread impact for this technology.

Principal applications benefitting from this technology include fabrication of functionally designed nanomaterials, and nanocomposites suitable for nanoscale sensors, lasers, memory chips, and photovoltaics. This new technology can help reduce cost, increase materials performance, mitigate environmental concerns, improved logistics, and realize new nanomaterials and architectures not possible with currently available methods.

Stress-Induced Fabrication (SIF)

Instead of chemistry, a SIF process uses physical force applied to arrays of commercially available nanoparticles to form new nanomaterials and nanocomposites with precisely controlled structure and tunable properties. Depending on the size, composition, and phase of the starting materials, a variety of nanostructures—such as nanorods, nanowires, nanosheets, and 3D porous networks—can be manufactured using metallic (e.g., Au, Ag), semiconducting (e.g., CdSe, PbSe), or magnetic (FePt) source materials. Alloy nanostructures can be fabricated by using binary nanoparticles. Nanomaterials can be directly fabricated on substrates such as Si and sapphire wafers, thereby enabling direct device integration during compression.

Sandia National Laboratories is a multi-mission laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND 2017-0831 M



Stress-induced Fabrication is a revolutionary nanofabrication process that enables the production of new functional materials with better performance and structure control.

Technology advancement

Current nanomaterial synthesis is dominated by chemical methods that require non-ambient processing conditions, highly trained operators, and complex chemical reactions involving expensive reactors and unforgiving control requirements. While improvements in chemical reaction kinetics have allowed chemical synthesis methods to generally keep pace with minimum performance requirements of typical nanomaterials applications, the SIF process can be tuned and directly integrated to meet the performance requirements of both current and new products. Concurrently, the SIF process can reduce cost, improve manufacturing logistics, and minimize environmental and safety concerns. Stress-Induced Fabrication has introduced a new capability for directly integrating the final nanomaterials into devices, a feature that is difficult or impossible to achieve with chemical synthesis processes.

Commercialization path

We are seeking partners to co-develop the technology for scale up and manufacturing.

Stress-Induced Fabrication targets following market areas:

- Nanomaterials fabrications
- Nanosensors such as stress sensors, bio/chemical sensors
- Memory chips
- Modulators for tuning bandgaps and lasing wavelength
- Defect reduction

For more information please contact:
Dr. Hongyou Fan
hfan@sandia.gov | (505) 272-7128
energy.sandia.gov