SAND2024-10720M

MARKET SHEET

Materials Data Driven Design (MAD³)

Sandia National Laboratories

This award-winning software enables accurate simulations of complex material deformation for a wide range of applications.

Commercial Copyright

Technology Readiness Level 8

Business Problem

Simulation engineers and manufacturers in automotive, aerospace, electronics, and other industries rely on predicting materials deformation under different conditions. Traditional materials testing methods require expensive and time-consuming experiments or computationally intensive simulations to account for these complexities, leading to significant costs and materials as well as time constraints. There are challenges in accurately predicting mechanical properties of materials that originate from complex internal polycrystalline structures. For example, metals are made up of very small crystals or grains. The arrangement of atoms in the grains form a polycrystalline structure that gives metals unique properties like the ability to stretch without breaking. Accurate predictions of how a material will deform or change shape is essential so industries can design and manufacture products that meet performance requirements, ensure safety, optimize efficiency, and reduce costs associated with material failure or inefficiency.

Customer Need

Manufacturers need a software solution that can accurately predict the behavior of metals by considering their internal structure. Metal alloys such as aluminum or steel used in stamping and forming manufacturing processes exhibit directional strength and formability that cause the metal to distort. This directional behavior, called plastic anisotropy, determines whether the material is capable of being shaped to the desired component fit and finish, and whether it will withstand the applied performance load. The cost of characterizing plastic anisotropy has skyrocketed because it requires specialized equipment and significant technical expertise. Customers seek a fast and accurate tool that eliminates the need for costly experiments and time-consuming simulations.

Competitive Advantage

MAD³ stands out as a powerful simulation software that combines accuracy and speed by leveraging machine learning and materials science techniques. Its scalability and user-friendly interface make it suitable for a wide range of materials science problems, providing a competitive advantage over existing commercial products.

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Next Steps

Sandia is seeking partners to develop and commercialize this technology. Collaborating with Sandia can enable further refinement and implementation of the testing protocol. For more information, please contact Sandia National Laboratories' Licensing and Technology Transfer office.

Technical Benefits

- **Simple to operate:** MAD^3 has an easy-to-use graphic user interface (GUI) that makes it accessible to users who do not have extensive technical knowledge or computer expertise.
- **Fast performance:** It predicts the parameters that characterize the directional mechanical behavior of a metal alloy 1,000 times faster than existing solutions. Fast and accurate simulations allow staff to efficiently account for the internal structure of materials, reducing the time associated with traditional methods.
- **Cost effective:** This technology offers significant savings for manufacturing companies by eliminating the need for costly experiments and reducing computational requirements.

Industries & Applications

- Automotive
- Aerospace
- Manufacturing
- Materials Science

Software Requirements

- **Hardware:** No special requirements
- **Operating System/Version:** Linux, MacOS, and Windows
- **Stand-Alone Code:** No additional or specialized software required.

Contact Us

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U.S. DEPARTMENT OF ENERGY NNSA National Nuclear Security Administration

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Technical Figures

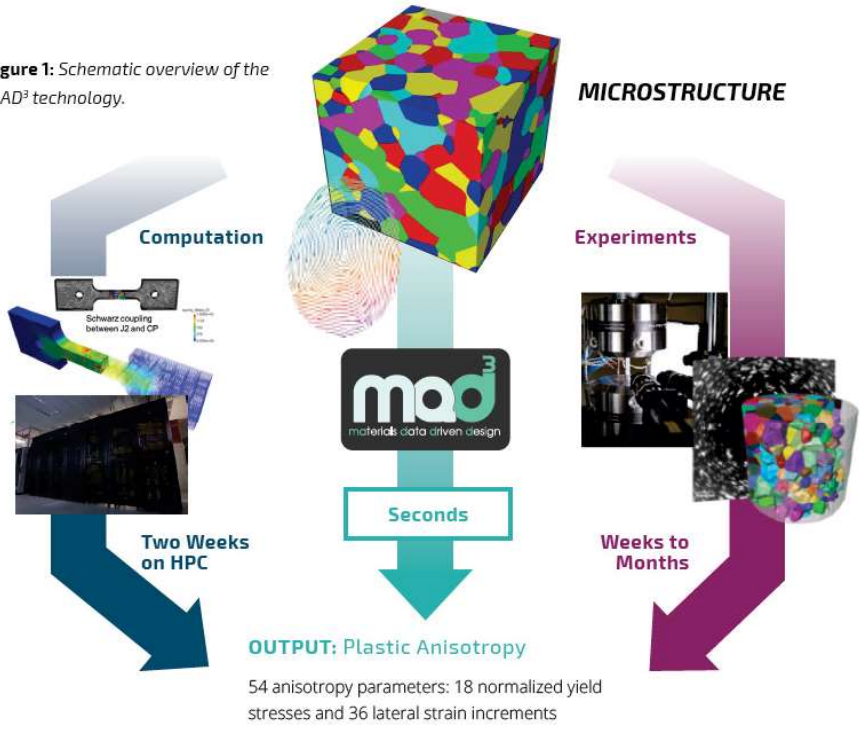

Figure 1: *Schematic overview of the MAD³ technology.*

	MAD³	Traditional Processes
Time to Result	**< 1 minute**	Tens of hours *(if calibrating the parameters using high-fidelity simulations)* ~6 months *(if calibrating the parameters using experiments)*
Uncertainty Quantification	**Yes**	No
Ease of Use	**Easy**	Difficult
Electrical Cost	**Nominal**	High
Subject Matter Expertise	**Minimal**	High
Resource Waste	**None**	Broken, discarded materials
Equipment Required	**Standard computer**	High-performance computing environment and high-end materials characterization laboratory

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