Cross-ministerial Strategic Innovation Promotion Program (SIP), Second Phase

5. “Materials Integration” for Revolutionary Design System of Structural Materials

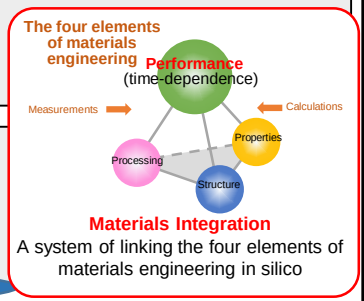
Vision

Outline

- Take critical steps **in the field of materials, where Japan has expertise and high-quality data**, in response to heavy investment by Europe, America, and China in AI-driven materials development
- **Revamp methods of materials development through integration of materials engineering and computer science** using **material integration (MI)** developed by industry, academia, and government, and lead the world in developing **inverse design MI to design materials and processes based on desired performance**.
- **Expand inverse design MI to advanced materials and processes** in order to accelerate social implementation.

Goals

- Develop inverse design MI for lowering material development costs and time by at least 50% and eliciting new material functions, and demonstrate its effectiveness; create a platform through which private companies and research institutes can utilize the MI system.
- Utilize inverse design MI to develop cutting-edge processes for manufacturing with a high degree of freedom composites and heat-resistant alloys to be used in actual components for power plants and other applications in the environment and energy industry, as well as the aircraft and medical and health care industries.



Materials Integration
A system of linking the four elements of materials engineering in silico

Exit Strategies

- Install a next-generation MI system for use by industry to solve inverse problems.
- Envision cutting edge materials and processes for industrial power plants and aircraft engines and airframes as applications for MI, and implement achievements in collaboration with material and heavy industry manufacturers.

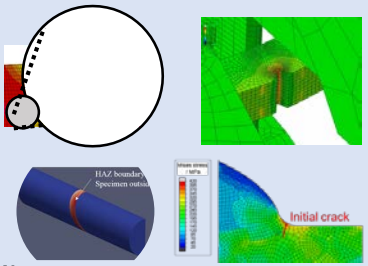
Socioeconomic impact

- Implementation of MI will accelerate materials development for raw materials manufacturers, strengthening industrial competitiveness.
  (The ten largest manufacturers of products processed from metals, chemicals, textiles/leather, ceramics/paper, containers/packaging, etc. had 1.5 trillion yen in R&D expenses. New materials development has been greatly accelerated, with sales expanding to 63 trillion yen.)
- There is increasing demand for dramatically lighter small/mid-size aircraft and more efficient engines.

Implementation

R&D content

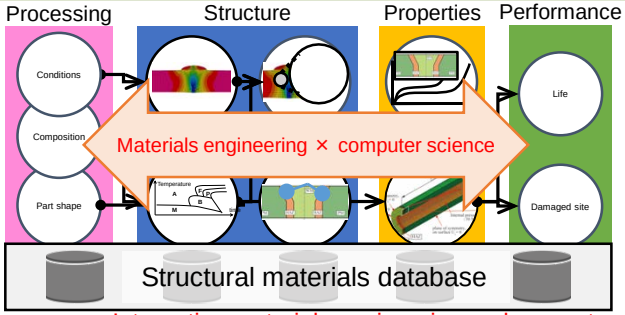
- Basic technology for inverse design MI
  - Techniques for analyzing inverse problems
  - Techniques for designing various material processes
  - Techniques for designing structures from atoms
  - Techniques for developing a database specific to structural materials
  - Integrated system technology as a basis for inverse design MI
- Potential applications for inverse design MI
  - Cutting edge structural materials (ultimate light/strong materials)
    - Develop multifunctional (flame-retardant) polymer composites
    - Develop next-generation ultra-high-strength steel/extra-super duralumin
  - Cutting edge processes (ultimate shaping freedom)
    - Establish AM technology for heat-resistant alloys (Ni-based, TiAl, etc.)
    - Establish fabrication and evaluation techniques for super-heat-resistant composites



Inverse analysis on the basis of a technology for predicting structures, cracking and other damage from processes.

Cutting-edge materials/processes

Basic inverse design MI technologies



- ✓ Inverse design MI is a key for global dominance
- ✓ Real materials have many factors, with myriad combinations

Integrating materials engineering and computer science for innovative materials development

Expand application to advanced materials/processes and demonstrate development efficiency
Envision the participation of material/heavy industry manufacturers representing Japan

Apply to cutting-edge structural materials/processes that are Japan’s forte

Participating ministries and agencies: Cabinet Office, MEXT, and METI