Computational Evaluation of Material Behavior from Multiscale Perspectives

Keywords: Multiscale modeling, Computational micromechanics, Finite element method

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Background A mechanical behavior of a material is investigated with numerical simulations based on nonlinear continuum mechanics from both macro- and microscopic viewpoints. Within this approach, the relationship between a strengthening effect and a bulk property is visualized on a computer.

Aim A computational framework has been developed to indicate the further direction of material research and development, in which experimental observation data and results of physical computation are integrated into a continuum-based model for practical materials.

Advanced Research Topics

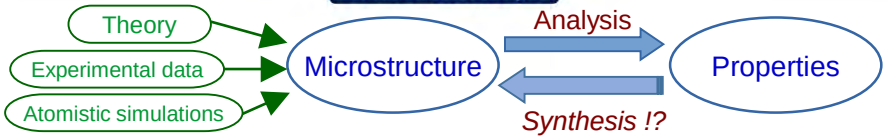
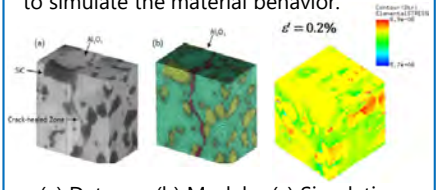


Image-based finite element modeling

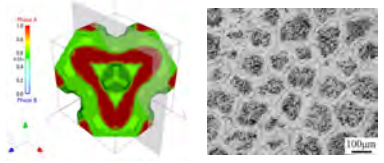
A numerical model is generated directly from the 3D image of the microstructure to simulate the material behavior.



(a) Data (b) Model (c) Simulation
Modeling and analysis of self-healing ceramics (collaboration with Dr. T. Osada)

Computational microstructure design

The strengthening effect of the microscopic morphology is optimized to indicate the direction of the microstructure design.



(a) Optimized result (b) Microstructure
Morphology optimization of strong phase (collaboration with Prof. K. Ameyama)

Publications

- I. Watanabe, et al., Advanced Structured Materials, Springer, 24 (2015) 541-555.
- I. Watanabe et al., Int. J. Numer. Methods Engrg., 89 (2012), 829-845.
- I. Watanabe et al., Int. J. Plasticity, 26 (2010), 570-585.

Applied area and future prospects

- Process-oriented materials R&D with multi-scale modeling
- Coupling with advanced observation techniques and physical computations
- Application to practical materials

Issues for technology transfer

- Computational materials design
- Fundamental investigation of material behavior with computational simulations
- Concurrent designing method with material and forming process