TIME TABLE

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	October 18	October 19	October 20	October 21	October 22
09.00 - 09.45	Registration	Le Bouar	Le Bouar	Le Bouar	Dingreville
09.45 - 10.30	Appolaire	Le Bouar	Le Bouar	Schneider	Dingreville
11.00 - 11.45	Appolaire	Schneider	Salvalaglio	Schneider	Dingreville
11.45 - 12.30	Appolaire	Schneider	Salvalaglio	Salvalaglio	Schneider
14.00 - 14.45	Le Bouar	Appolaire	Schneider	Salvalaglio	
14.45 - 15.30	Le Bouar	Appolaire	Schneider	Salvalaglio	
16.00 - 16.45	Appolaire	Salvalaglio	Dingreville	Dingreville	
16.45 - 17.30	Appolaire	Salvalaglio	Dingreville	Dingreville	
18.00	Poster Session - Aperitif				

ADMISSION AND ACCOMMODATION

The course is offered in a hybrid format, allowing participants the flexibility to attend either in person or remotely via the Microsoft Teams platform. Admission to on-site attendance is granted on a first-come, first-served basis to comply with the capacity of the lecture room.

Registration fees:

- Early Bird On-Site Participation: € 650.00 + VAT*
Deadline: August 18, 2027

- Late On-Site Participation: € 800.00 + VAT*
Deadline: October 6, 2027

- Live Streaming Online Participation: € 250.00 + VAT*
Deadline: October 6, 2027

On-site participation includes a complimentary bag, five fixed menu buffet lunches, hot beverages, downloadable lecture notes.
Online participation includes downloadable lecture notes.

Application forms should be submitted online through the website: http://www.cism.it. A confirmation message will be sent to participants whose applications are accepted.
Upon request, and subject to availability, a limited number of on-site participants can be accommodated at the CISM Guest House for € 35 per person per night.
To request accommodation, please contact: foresteria@cism.it

** where applicable; bank charges are not included - Italian VAT is 22%.*

CANCELLATION POLICY

Applicants may cancel their registration and receive a full refund by notifying the CISM Secretariat in writing (via email) no later than:
- August 18, 2027, for early bird on-site participation;
- September 18, 2027, for late on-site participation;
- October 6, 2027, for online participation.

No refunds after the deadlines. Cancellation requests received before these deadlines and incorrect payments will be subject to a € 50.00 handling fee.

CISM GRANTS

A limited number of participants from universities and research centers who do not receive support from their institutions can request a waiver of the registration fee and/or free lodging.
Requests must be submitted via the CISM website by **August 18, 2027**. Applicants should select the relevant option in the online application form and provide a curriculum vitae and a letter of recommendation from their department head or supervisor confirming that their institution is unable to provide financial support. Preference will be given to applicants from countries that sponsor CISM.

For further information please contact:

CISM (Seat of the course)
Palazzo del Torso - Piazza Garibaldi 18 - 33100 Udine (Italy)
tel. +39 0432 248511 (6 lines)
e-mail: info@cism.it | www.cism.it

Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

ACADEMIC YEAR 2027
Ted Bohdan Belytschko Session

PHASE-FIELD MODELLING OF MICROSTRUCTURE EVOLUTION: MULTIPHYSICS AND COMPUTATIONAL APPROACHES

CISM Advanced School
coordinated by

Benoît Appolaire
Université de Lorraine - CNRS, Institut Jean Lamour
Nancy, France

Daniel Schneider
Karlsruhe Institute of Technology (KIT)
Karlsruhe, Germany

Udine ***October 18 - 22*** 2027

PHASE-FIELD MODELLING OF MICROSTRUCTURE EVOLUTION: MULTIPHYSICS AND COMPUTATIONAL APPROACHES

Phase-field models provide a framework for studying how moving interfaces interact with diffusion, internal stresses and deformation in solid materials. These interactions govern a range of phenomena, including precipitation, solid-state phase transformations and grain-boundary migration. With microstructure evolution as its central theme, this Advanced School gives participants the tools to formulate phase-field models, interpret their parameters and choose numerical approaches suited to the physical problem.

The school begins with the thermodynamic and variational foundations of phase-field modelling. Lectures introduce free-energy functionals, order parameters and gradient energy, and explain the physical meaning of Allen–Cahn and Cahn–Hilliard kinetics. Quantitative formulations and thin-interface asymptotics show how diffuse-interface models can recover the kinetics of sharp interfaces.

The mechanics lectures examine how eigenstrains, elastic anisotropy and long-range stress fields change the driving forces and morphologies of phase transformations. Lectures on continuum and crystal plasticity then show how plastic relaxation and crystallographic slip interact with evolving microstructures. A dedicated series on crystalline interfaces covers capillarity, grain-boundary migration and the role of interfacial defects such as disconnections.

The school also covers sharp phase-field formulations that reduce grid pinning and improve computational efficiency, as well as data-driven approaches for accelerating simulations. Participants will examine what surrogate models, reduced-order methods and physics-informed learning can contribute to phase-field modelling and where their predictions require particular care. A poster session on the first day will give participants an opportunity to introduce their research and discuss it with lecturers and peers.

Target audience

Doctoral students, postdoctoral researchers, early-career faculty and researchers in academia and industry working in materials science, computational mechanics, applied mathematics or related fields.

PRELIMINARY SUGGESTED READINGS

Chen, L.-Q. Phase-field models for microstructure evolution. Annu. Rev. Mater. Res. 32, 113–140 (2002). https://doi.org/10.1146/annurev.matsci.32.112001.132041

Moelans, N., Blanpain, B. & Wollants, P. An introduction to phase-field modeling of microstructure evolution. Calphad 32, 268–294 (2008). https://doi.org/10.1016/j.calphad.2007.11.003

Karma, A. & Rappel, W.-J. Quantitative phase-field modeling of dendritic growth in two and three dimensions. Phys. Rev. E 57, 4323–4349 (1998). https://doi.org/10.1103/PhysRevE.57.4323

Finel, A., et al. Sharp phase field method. Phys. Rev. Lett. 121, 025501 (2018). https://doi.org/10.1103/PhysRevLett.121.025501

Schneider, D., et al. Small strain multiphase-field model accounting for configurational forces and mechanical jump conditions. Comput. Mech. 61, 277–295 (2018). https://doi.org/10.1007/s00466-017-1458-4

Prahs, A., et al. A multiphase-field approach to small strain crystal plasticity accounting for balance equations on singular surfaces. Comput. Mech. 73, 773–794 (2024). https://doi.org/10.1007/s00466-023-02389-6

Ammar, K., Appolaire, B., Forest, S., Cottura, M., Le Bouar, Y. & Finel, A. Modelling inheritance of plastic deformation during migration of phase boundaries using a phase field method. Meccanica 49, 2699–2717 (2014). https://doi.org/10.1007/s11012-014-0011-1

Salvalaglio, M., et al. Disconnection-mediated migration of interfaces in microstructures: II. Diffuse interface simulations. Acta Mater. 227, 117463 (2022). https://doi.org/10.1016/j.actamat.2021.117463

Qiu, C., Salvalaglio, M., Srolovitz, D. J. & Han, J. Interface faceting–defaceting mediated by disconnections. Acta Mater. 251, 118880 (2023). https://doi.org/10.1016/j.actamat.2023.118880

Karniadakis, G. E., et al. Physics-informed machine learning. Nat. Rev. Phys. 3, 422–440 (2021). https://doi.org/10.1038/s42254-021-00314-5

Montes de Oca Zapiain, D., Stewart, J. A. & Dingreville, R. Accelerating phase-field-based microstructure evolution predictions via surrogate models trained by machine learning methods. npj Comput. Mater. 7, 3 (2021). https://doi.org/10.1038/s41524-020-00471-8

Dingreville, R., et al. Benchmarking machine learning strategies for phase-field problems. Model. Simul. Mater. Sci. Eng. 32, 065019 (2024). https://doi.org/10.1088/1361-651X/ad5f4a.

INVITED LECTURERS

Benoît Appolaire - Institut Jean Lamour, Université de Lorraine–CNRS, Nancy, France
7 lectures on:
Thermodynamic Foundations and Quantitative Phase-Field Modelling.
Free-energy functionals, order parameters, Allen–Cahn and Cahn–Hilliard kinetics, and thin-interface asymptotics for quantitative phase-field models of microstructure evolution.

Rémi Dingreville - Center for Integrated Nanotechnologies, Sandia National Laboratories, Albuquerque, New Mexico, USA
7 lectures on:
Data-Driven Methods for Phase-Field Modelling.
Data-driven phase-field modelling using surrogate models, reduced-order methods and physics-informed learning. Opportunities and limitations for accelerating microstructure simulations.

Yann Le Bouar - *Laboratoire d'Étude des Microstructures (ONERA–CNRS), Châtillon, France*
7 lectures on:
Microelasticity and Sharp Phase-Field Methods.
Microelasticity, eigenstrains and long-range elastic interactions in phase transformations, followed by sharp phase-field formulations, grid pinning and quantitative interface kinetics.

Marco Salvalaglio - TUD Dresden University of Technology, Dresden, Germany
7 lectures on:
Phase-Field Modelling of Crystalline Interfaces.
Thermodynamics, mechanics and kinetics of crystalline interfaces. Capillarity, grain-boundary migration, disconnections and the coupling of interface motion with mechanical driving forces.

Daniel Schneider - Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
7 lectures on:
Coupling Phase-Field Modelling with Continuum Mechanics and Plasticity.
Thermodynamically consistent coupling of phase-field models with mechanical fields. Mechanical jump conditions, configurational forces, continuum and crystal plasticity, and their influence on interface motion, phase transformation kinetics and microstructure evolution.

LECTURES

All lectures will be given in English.
Lecture notes can be downloaded from the CISM web site.
Instructions will be sent to accepted participants.