

# Kumar Ankit, Ph.D.

## Curriculum Vitae

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### EDUCATION

**Ph.D.** in Mechanical Engineering *summa cum laude* 06/2012–12/2015  
Karlsruhe Institute of Technology, Karlsruhe, Germany. *(with highest honor)*

Dissertation title: Phase-field modeling of microstructural pattern formation in alloys and geological veins.

**Integrated Dual Degree (Bachelor+Master)** in *First Class* 08/2005–05/2010  
Metallurgical Engineering  
Indian Institute of Technology, Banaras Hindu University  
(IIT, BHU), Varanasi, India.

### PROFESSIONAL EXPERIENCE

**Assistant Professor (Tenure-track)** 08/2017–present  
Materials Science & Engineering, School for Engineering of Matter, Transport & Energy, Arizona State University, Tempe, United States.

### PROFESSIONAL PREPARATION

**Postdoctoral Research Associate** 08/2016–07/2017  
Materials Science and Engineering, Texas A&M University, College Station, United States.

**Group Leader** 12/2015–07/2016  
Institute of Applied Materials (Computational Materials Science), Karlsruhe Institute of Technology, Karlsruhe, Germany.  
Group: Quantitative modeling of phase transformations.

**Research Assistant** 06/2012–12/2015  
Institute of Materials and Processes, Karlsruhe University of Applied Sciences, Karlsruhe, Germany.

**Research Assistant** 06/2010–05/2012  
Chair of Materials and Process Simulations, University of Bayreuth, Bayreuth, Germany.

### RESEARCH INTERESTS

My research group specializes in the development and application of mesoscopic modeling techniques and their integration with continuum approaches for both fundamental and applied research in microstructure science and engineering. I am currently interested in deciphering computational pathways to optimally design microstructure processing routes. Target areas include solidification, solid-state transformations and grain coarsening in multicomponent alloys and geomaterials, electromigration-induced damage, and self-organization in polymers and vapor-deposited films.

## RESEARCH GRANTS

<b>Principal investigator</b> Grant number: AN 1245/1-1 German Research Foundation's Young Investigator's Grant (DFG Nachwuchsakademie) Project title: Microstructural pattern formation during eutectoid transformation in multicomponent steels.	278,000 €	03/2016 - 03/2019
<b>Principal investigator</b> Fulton Undergraduate Research Initiative (FURI) Arizona State University	\$2,500	02/2018 - 06/2018

## AWARDS & FELLOWSHIPS

08/2014:	<i>Poster award</i> at the Third International Symposium on Phase-field Methods, Pennsylvania State University, State College, United States.
06/2012 - 05/2015:	'Graduate School 1483' fellowship of the German Research Foundation (DFG Graduiertenkolleg 1483).
06/2010 - 05/2012:	Research fellowship 718 'FRACS' of the German Society for Petroleum and Coal Science and Technology (DGMK).

## EXTERNAL SERVICE

### Referee

Federal-agencies:	Served on a panel that reviews graduate students' proposals for the NASA Space Technology Research Fellowship (NSTRF) in the Technology Area 11 – Modeling, Simulation, Information Technology and Processing.
Scientific Journals:	Journal of Crystal Growth (Elsevier), Scientific Reports (Nature Publishing Group), Physica D : Nonlinear Phenomena (Elsevier), Journal of Materials Science (Springer), Materials Research Letters (Taylor & Francis), Science and Technology of Welding and Joining (Taylor & Francis), Materials Science and Engineering A (Elsevier), IEEE Transactions on Knowledge and Data Engineering (IEEE), Journal of Phase Equilibria and Diffusion (Springer), Materials Theory (Springer).

### Organizing Activities

Lead-organizer of the minisymposium titled *Recent advances in phase-field modeling and analysis of microstructural evolution* at the upcoming **SIAM Conference on Mathematical Aspects of Materials Science 2018 (MS 18)** in Portland, OR. This mini-symposium which features 20 invited lectures delivered by experts from all across the globe and a poster session for students focused on the recent developments and applications of the phase-field method and numerical post-processing techniques for microstructural quantification.

## TEACHING

Course	Title	Semester	Level
MSE 494/598	Microstructure Modeling & Simulations	Fall 2017	Graduate/Undergraduate
MSE 355	Structure and Defects	Fall 2018	Undergraduate
MSE 335	Materials Kinetics	Spring 2019	Undergraduate

**MENTORING****Arizona State University:****Graduate students**

08/2017 -present:	Phase-field modeling of nanostructural self-assembly in vapor-deposited films	Rahul Raghavan
08/2017 -present:	Phase-field modeling of electromigration-induced defects in polycrystalline interconnects	Shruti Sharma

**Undergraduate students**

02/2018 -present:	Computational pathways to the optimal design of polymer processing routes	Timoteo Diaz
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**Postdoctoral researchers**

11/2017 - present:	Mechanical testing of vapor-deposited films	Dr. Benyamin Gholami Bazehhour (co-advised with Prof. Kiran Solanki)
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**Karlsruhe Institute of Technology, Germany:** As *Leader* of the group - *Quantitative Modeling of Phase Transformations*, co-supervision of:

**Graduate students**

12/2013 - 08/2015:	Phase-field modeling of diffusive and displacive transformation in binary steel	Tobias Mittnacht (Master's thesis)
08/2014 - present:	Phase-field modeling of electromigration-induced grain-boundary grooving and hillock formation in interconnects, Electric-field induced pattern formation in diblock copolymers	Arnab Mukherjee
08/2014 - present:	Rapid Solidification in Ni-Zr glass-forming alloys	Sumanth Enugala
07/2015 - present:	Rayleigh instabilities of pearlitic lamellae during sub-critical annealing of steel	Prince Gideon Kubendran Amos
04/2016 - present:	Phase-field modeling of polycrystalline evolution in geological veins	Nishant Prajapati
04/2016 - present:	Influence of convection on directionally solidified pattern evolution	Pavan Laxmipathy Veluvali

**Undergraduate students**

06/2013 - 10/2013:	Phase-field study of polycrystalline calcite evolution in geological veins	Sebastian Farag
11/2012 - 10/2013:	Phase-field study of pearlitic growth in mixed diffusion-controlled regime.	Tobias Mittnacht

**Postdoctoral researchers**

08/2014 - 03/2016:	Phase-field simulations of curvature-induced cascading of Widmanstätten-ferrite plates	Dr. Avisor Bhattacharya
05/2016 - present:	Microstructural pattern formation during eutectoid transformation in multicomponent steels	Dr. Leslie Mushongera

**MEDIA COVERAGE**

- American Association for the Advancement of Science (2018). Scientists discover new field affecting metals solidification [Press release]. Retrieved from [https://www.eurekalert.org/pub\\_releases/2018-02/fiot-sdn020118.php](https://www.eurekalert.org/pub_releases/2018-02/fiot-sdn020118.php)

- Foundry Management & Technology (2018). Reanalyzed Data Sheds Light on Solidification Process [Press release]. Retrieved from <http://www.foundrymag.com/meltpour/reanalyzed-data-sheds-light-solidification-process>

## PUBLICATIONS

### Refereed research papers

1. Mukherjee, A., K. Ankit<sup>†</sup>, M. Selzer, and B. Nestler (2018). Electromigration-induced surface drift and slit propagation in polycrystalline interconnects: Insights from phase-field simulations. *Physical Review Applied* **Accepted**.
2. Mushongera, L., P. Amos, B. Nestler, and K. Ankit (2018). Phase-field simulations of pearlitic divergence in Fe—Mn steels. *Acta Materialia* **in press**. doi: 10.1016/j.actamat.2018.02.059.
3. Xing, H., H. Chen, K. Ankit, X. Dong, and K. Jin (2018). Growth direction selection of tilted dendritic arrays in directional solidification over a wide range of pulling velocity: A phase-field study. *International Journal of Heat and Mass Transfer* **117**, 1107–1114. doi: 10.1016/j.ijheatmasstransfer.2017.10.086.
4. Bhattacharya, A., K. Ankit<sup>†</sup>, and B. Nestler (2017). Phase-field simulations of curvature-induced cascading of Widmanstätten-ferrite plates. *Acta Materialia* **123**, 317–328. doi: 10.1016/j.actamat.2016.10.035.
5. Glicksman, M. and K. Ankit (2017). Detection of Capillary-Mediated Energy Fields on a Grain Boundary Groove: Solid–Liquid Interface Perturbations. *Metals* **7**(12), 547. doi: 10.3390/met7120547.
6. Ankit<sup>†</sup>, K., H. Xing, M. Selzer, B. Nestler, and M. Glicksman (2016). Surface rippling during solidification of binary polycrystalline alloy: Insights from 3-D phase-field simulations. *Journal of Crystal Growth* **457**, 52–69. doi: 10.1016/j.jcrysgro.2016.05.033.
7. Meller, C., J. Bremer, K. Ankit<sup>†</sup>, and 33 others (2016). Integrated research as key to the development of a sustainable geothermal energy technology. *Energy Technology (invited review)*, In press. doi: 10.1002/ente.201600579.
8. Mukherjee, A., K. Ankit<sup>†</sup>, R. Mukherjee, and B. Nestler (2016). Phase-field modeling of grain-boundary grooving under electromigration. *Journal of Electronic Materials* **45** (12), 6233–6246. doi: 10.1007/s11664-016-4848-z.
9. Mukherjee, A., K. Ankit<sup>†</sup>, A. Reiter, M. Selzer, and B. Nestler (2016). Electric-field-induced lamellar to hexagonally perforated lamellar transition in diblock copolymer thin films : Kinetic pathways. *Physical Chemistry Chemical Physics* **18**, 25609–25620. doi: 10.1039/C6CP04903F.
10. Mukherjee, A., R. Mukherjee, K. Ankit<sup>†</sup>, A. Bhattacharya, and B. Nestler (2016). Influence of substrate interaction and confinement on electric-field-induced transition in symmetric block-copolymer thin films. *Physical Review E* **93**(3), 032504. doi: 10.1103/PhysRevE.93.032504.
11. Ankit<sup>§</sup>, K., T. Mittnacht, R. Mukherjee, and B. Nestler (2015). Evolution of mixed cementite morphologies during non-cooperative eutectoid transformation in Fe-C steels. *Computational Materials Science* **108** (B), 342–347. doi: 10.1016/j.commatsci.2015.03.002.
12. Ankit<sup>§</sup>, K., R. Mukherjee, and B. Nestler (2015). Deviations from cooperative growth mode during eutectoid transformation: Mechanisms of polycrystalline eutectoid evolution in Fe-C steels. *Acta Materialia* **97**, 316–324. doi: 10.1016/j.actamat.2015.06.050.
13. Ankit<sup>§</sup>, K., M. Selzer, C. Hilgers, and B. Nestler (2015). Phase-field modeling of fracture cementation processes in 3-D. *Journal of Petroleum Science Research* **4** (2), 79–96. doi: 10.12783/jpsr.2015.0402.04.
14. Ankit<sup>§</sup>, K., J. Urai, and B. Nestler (2015). Microstructural evolution in bitaxial crack-seal veins: A phase-field study. *Journal of Geophysical Research B: Solid Earth* **120**(5), 3096–3118. doi: 10.1002/2015JB011934.

15. Ankit<sup>S</sup>, K., R. Mukherjee, T. Mittnacht, and B. Nestler (2014). Deviations from cooperative growth mode during eutectoid transformation: Insights from a phase-field approach. *Acta Materialia* **81**, 204–210. DOI: 10.1016/j.actamat.2014.08.015.
16. Ankit<sup>S</sup>, K., A. Choudhury, C. Qin, S. Schulz, M. McDaniel, and B. Nestler (2013). Theoretical and numerical study of lamellar eutectoid growth influenced by volume diffusion. *Acta Materialia* **61**(11), 4245–4253. DOI: 10.1016/j.actamat.2013.03.050.
17. Ankit<sup>S</sup>, K., B. Nestler, M. Selzer, and M. Reichardt (2013). Phase-field study of grain boundary tracking behavior in crack-seal microstructures. *Contributions to Mineralogy and Petrology* **166**(6), 1709–1723. DOI: 10.1007/s00410-013-0950-x.
18. Ankit\*, K. and N. Prasad (2011). Simulation of creep cavity growth in Inconel 718 alloy. *Materials Science and Engineering A* **528**(12), 4209–4216. DOI: 10.1016/j.msea.2011.02.012.
19. Fleck, M., L. Mushongera, D. Pilipenko, K. Ankit<sup>S</sup>, and H. Emmerich (2011). On phase-field modeling with a highly anisotropic interfacial energy. *European Physical Journal Plus* **126**(10), 1–11. DOI: 10.1140/epjp/i2011-11095-7.
20. Ankit\*, K. (2009). Remaining creep life assessment techniques based on creep cavitation modeling. *Metallurgical and Materials Transactions A* **40**(5), 1013–1018. DOI: 10.1007/s11661-009-9781-9.

## Books

1. Ankit<sup>S</sup>, K. (2016). *Phase-field modeling of microstructural pattern formation in alloys and geological veins*. Vol. 58. Series of Institute of Applied Materials, Karlsruhe Institute of Technology. KIT Scientific Publishing, 242 pages. DOI: 10.5445/KSP/1000052440.

## In review

1. Ankit, K., B. Derby, A. Misra, and M. Demkowicz (n.d.). Numerical and experimental investigation of phase separation in Cu-Mo vapor-deposited films.
2. Gideon, P., K. Ankit, A. Bhattacharya, and B. Nestler (n.d.). Phase field study of volume diffusion-controlled pearlite spheroidization.
3. Mukherjee, A., K. Ankit, M. Selzer, and B. Nestler (n.d.). Electromigration-induced surface drift and slit propagation in polycrystalline interconnects: Insights from phase-field simulations.
4. Nani, E., K. Ankit, and B. Nestler (n.d.). Reformulation and validation of Jackson-Hunt relations for intermetallic eutectic lamellae with curved surfaces.
5. Prajapati, N., M. Selzer, B. Nestler, B. Busch, C. Hilgers, and K. Ankit (n.d.). Three-dimensional phase-field investigation of pore space cementation and permeability in Quartz sandstone.

## CONFERENCE PRESENTATIONS

### Invited talks

1. Controlling nanostructured morphologies in vapor-deposited thin films: Towards guided vapor deposition (2018). In: *International Conference on Plasticity, Damage, and Fracture*. San Juan, PR, United States.
2. Morphological self-assembly in vapor-deposited binary films (2018). In: *SIAM Conference on Mathematical Aspects of Materials Science*. Portland, OR, United States.
3. Controlling the assembly of sputtered, multiphase-metallic thin films (2017). In: *Engineering Mechanics Institute Conference (EMI 2017)*. San Diego, United States (upcoming).
4. Microstructural pattern formation during eutectoid transformation in multicomponent steels (2015). In: *German Research Foundation's Early Career Investigators Workshop (DFG Nachwuchssakademie)*. Schlitz, Germany.
5. Phase-field modeling of crystal growth in geological veins - A first look (2014). In: *3<sup>rd</sup> International Symposium on Phase-field Method (PFM) 2014*. State College, United States.

6. Mathematical modeling of microstructural evolution in geological vein networks and solid-state phase transformations (2013). In: *Workshop on polycrystalline growth - New insights from experiments and modeling*. Karlsruhe, Germany.
7. Numerical methods to study phase transformation and transport mechanisms in veins (2013). In: *Petrotherm Seminar of the division of Geothermal Energy (AGW, KIT)*. Karlsruhe, Germany.
8. Phase-field modeling of microstructural pattern formation in eutectoid steels (February 2017). In: *Department of Mechanical Engineering, San Diego State University*. San Diego, United States.
9. Phase-field modeling of microstructural pattern formation in eutectoid steels (February 2017). In: *School for Engineering of Matter, Transport & Energy, Arizona State University*. Tempe, United States.
10. Phase-field modeling of microstructural pattern formation in eutectoid steels (February 2017). In: *Department of Mechanical Engineering, University of Louisville*. Louisville, United States.
11. Phase-field modeling of microstructural pattern formation in eutectoid steels (March 2017). In: *Department of Mechanical and Aerospace Engineering, University of Alabama in Huntsville*. Huntsville, United States.
12. Phase-field modeling of microstructural pattern formation in eutectoid steels (March 2017). In: *Department of Materials Science & Engineering, Texas A&M University*. College Station, United States.

### Contributed talks

1. Predicting Self-organization of Nanostructured Morphologies in Physical Vapor Deposited Phase-separating Alloys (2018). In: *TMS Annual Meeting*. Phoenix, United States.
2. Self-organization of Nanostructured Morphologies in Physical Vapor Deposited Phase-separating Multicomponent Alloys (2018). In: *13<sup>th</sup> World Congress in Computational Mechanics*. New York, United States.
3. Tailoring of epitaxially deposited nanostructured thin films: Insights from a phase-field approach. (2016). In: *Texas A&M University Postdoctoral Research Symposium*. College Station, United States.
4. Amending the theory of non-cooperative eutectoid transformation: insights from phase-field simulations (2015). In: *TMS Annual Meeting*. Orlando, United States.
5. Phase-field investigation of capillary-mediated interface perturbations (2015). In: *European Conference on Crystal growth*. Bologna, Italy.
6. A three-dimensional phase-field study of grain boundary tracking behavior in crack-seal microstructures. (2013). In: *European Geosciences Union - General Assembly*. Vienna, Austria.
7. Computational study of pearlite growth in mixed diffusion-controlled regime (2013). In: *2<sup>nd</sup> World Congress on Integrated Computational Materials Engineering*. Salt Lake City, United States.
8. Theoretical and numerical study of eutectoid transformation in diffusion-controlled regime (2013). In: *Workshop on Composite Research in Mechanics and Forum for Metal Plasticity and Functionally Graded Structures*. Paderborn, Germany.
9. Modeling mineral vein dynamics: A phase-field approach. (2011). In: *European Geosciences Union - General Assembly*. Vienna, Austria.

### Co-authored abstracts

1. Ankit, K., B. Derby, A. Misra, and M. Demkowicz (2018). Predicting Self-Organization of Nanostructured Morphologies in Vapor Deposited Phase-Separating Binary Alloys. In: *MRS Spring Meeting*. Phoenix, United States.
2. Glicksman, M. and K. Ankit (2018). Interface Fields Affecting Solidification Microstructure. In: *TMS Annual Meeting*. Phoenix, United States.
3. Glicksman, M. and K. Ankit (2017). Autogenous perturbations: Controlling solidification microstructures. In: *The 6<sup>th</sup> Decennial Conference on Solidification Processing*. Old Windsor, United Kingdom.

4. Glicksman, M. and K. Ankit (2017). Capillary-mediated interfacial perturbation fields: Their exposure via phase-field equilibration. In: *TMS Annual Meeting*. San Diego, United States.
5. Mccue, I., K. Ankit, and M. Demkowicz (2017). Averting flow localization in metal nanocomposites by tailoring microstructure morphology. In: *MRS Spring Meeting*. Phoenix, United States.
6. Mukherjee, A., K. Ankit, and B. Nestler (2017). 3-D phase-field modeling of electromigration-induced damage in polycrystalline thin films : Grain-boundary slit propagation and hillock formation. In: *TMS Annual Meeting*. San Diego, United States.
7. Mushongera, L., K. Ankit, and B. Nestler (2017). Microstructural pattern formation during eutectoid transformation in Fe-Mn-C steels: Phase-field simulations. In: *TMS Annual Meeting*. San Diego, United States.
8. Phase-field modeling of grain-boundary grooving and surface drift under homogeneous electromigration (2017). In: *TMS Annual Meeting*. San Diego, United States.
9. Bhattacharya, A., K. Ankit, and B. Nestler (2016). A Phase-field Study of Cascading Widmanstätten-ferrite Plates. In: *TMS Annual Meeting*. Nashville, United States.
10. Mukherjee, A., K. Ankit, and B. Nestler (2016). Interplay of substrate interaction, electric field and confinement on microphase separation of diblock copolymers. In: *TMS Annual Meeting*. Nashville, United States.
11. Mukherjee, A., K. Ankit, and B. Nestler (2016). Morphological stability of interfaces under electromigration condition: insights from phase-field study. In: *TMS Annual Meeting*. Nashville, United States.
12. Nani, E., K. Ankit, and B. Nestler (2016). Theoretical and numerical study of eutectic growth kinetics of NiZr-NiZr<sub>2</sub> alloy at low undercoolings. In: *8<sup>th</sup> International Conference on Multiscale Materials Modeling*. Dijon, France.
13. Schneider, D., K. Ankit, O. Tschukin, M. Selzer, and B. Nestler (2015). Phase-field modeling of solid-solid phase transformations. In: *9<sup>th</sup> European Solid Mechanics Conference*. Madrid, Spain.

### Poster presentations

1. Microstructural pattern formation during eutectoid transformation in multicomponent steels (2016). In: *German Research Foundation's Young Investigator's Academy (DFG Nachwuchsakademie): Proposal Review*. Berlin, Germany.
2. Microstructural pattern formation in crack-sealing veins: A phase-field study (2015). In: *Workshop on Geothermal Energy (Helmholtz foundation)*. Karlsruhe, Germany.
3. Phase-field method as a microstructure modeling tool for interdisciplinary research: Overview (2015). In: *TMS Annual Meeting*. Orlando, United States.
4. Amending the theory of non-cooperative eutectoid transformation: an ICME approach (2014). In: *ICMEg*. Rolduc Abbey, Netherlands.
5. Deviations from cooperative growth mode during eutectoid transformation: Insights from phase-field simulations (2014). In: *3<sup>rd</sup> International Symposium on Phase-field Method (PFM) 2014, State College*. (awarded poster prize).
6. Computational study of flow anisotropy in sheared fractures with self-affine surfaces (2013). In: *European Geosciences Union - General Assembly*. Vienna, Austria.