



دانشکده مهندسی مکانیک و انرژی، دانشگاه شهید بهشتی



# Mechanics of architected materials

a journey towards sustainable future materials



**دکتر محمود موسوی**

دانشیار دانشکده مهندسی و علوم مواد، دانشگاه  
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Faculty of Mechanical and Energy Engineering, Shahid Beheshti University



# Mechanics of architected materials

a journey towards sustainable future materials



**Dr. Mahmoud Mousavi**

Associate Professor, Department of Materials Science  
and Engineering, Uppsala University, Sweden

Abstract: Materials-by-design is a potential solution for the challenges in sustainable development. In this perspective, thanks to additive manufacturing (AM), the internal architecture complements the chemical composition to broaden the library of materials for industry. The so-called architected materials, once designed efficiently, can contribute to more resource-efficient material use with improved recyclability. In this talk, we will look into the mechanics of architected materials. The AM-related aspects regarding manufacturing of such materials will also be addressed. The discussion will include examples regarding failure, fatigue, and energy dissipation in such materials.



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10:00 (IRAN)



<http://194.225.24.96/defa-mechanic-2/>

## **Mechanics of architected materials: a journey towards sustainable future materials**

Mahmoud Mousavi

Division of Applied Mechanics, Department of Materials Science and Engineering, Uppsala University, Sweden

**Abstract:** Materials-by-design is a potential solution for the challenges in sustainable development. In this perspective, thanks to additive manufacturing (AM), the internal architecture complements the chemical composition to broaden the library of materials for industry. The so-called architected materials, once designed efficiently, can contribute to more resource-efficient material use with improved recyclability. In this talk, we will look into the mechanics of architected materials. The AM-related aspects regarding manufacturing of such materials will also be addressed. The discussion will include examples regarding failure, fatigue, and energy dissipation in such materials.

## Curriculum Vitae

### 1. Full name and date

- Name: S. Mahmoud Mousavi
- Date of writing the CV: October, 2021
- Birth date: March 24, 1983
- Contact details: **Email:** [mahmoud.mousavi@angstrom.uu.se](mailto:mahmoud.mousavi@angstrom.uu.se)  
**Mob:** +46 76-868 57 37
- Webpage: <https://katalog.uu.se/profile/?id=N19-1258>

### 2. Employments

- 2019-present: Associate Professor in Applied Mechanics, Department of Materials Science and Engineering Uppsala University, Sweden.
- 2016-2019: Senior Lecturer in Mechanical Engineering, Department of Engineering and Physics, Karlstad University, Sweden.
- Jan-Jun 2016: Visiting Postdoctoral Researcher, Department of Engineering Science, University of Oxford, UK
- 2014-2015: Visiting Postdoctoral Researcher, School of Engineering, Aristotle University of Thessaloniki, Greece
- Jun 2014: Visiting Postdoctoral Researcher, Department of Engineering Science, University of Oxford, UK
- 2012-2016: Postdoctoral Researcher and Lecturer, Department of Civil Engineering, Aalto University, Finland

### 3. PhD degree

- **Date:** 21 Dec 2011, Ph.D. in Mechanical Engineering, Applied Mechanics.
- **University:** Tehran Polytechnic, Tehran, Iran
- **Title:** Antiplane elastodynamic analysis of cracked FGM layers with viscous damping

### 4. List of acquired external funding

- **2019-2022** Starting grant from Swedish Research Council  
Project: Defect engineering in metamaterials based on generalized continuum modeling  
Total amount: 3 600 000 SEK  
Level of responsibility: Main applicant
- **2018-2019** Knowledge Foundation: KKS, NU17  
Project: Web-based courses for international positioning of strategic research groups.  
Level of responsibility: co-applicant  
Total amount: 6 379 272 SEK  
Sub amount for Mahmoud Mousavi: 1 186 000 SEK
- **2012-2016** Aalto University research grant as postdoctoral fellowship (2+3 years)  
Project: Size effects in structures  
Level of responsibility: main applicant  
Total amount: 3 000 000 SEK
- **2016** Foundation for Aalto University Science and Technology; Jubilee Fund, Finland  
Project: Dislocation-based Fracture mechanics in Generalized Continuum Mechanics: Experiment and Theory.  
Total amount: 60 000 SEK  
Level of responsibility: Main applicant
- **2014** General Secretariat of Research and Technology of Greece  
Project acronym: Hellenic ERC-13 and ARISTEIA II

Project: Internal Length Gradient Mechanics across Scales and Materials: Theory, Experiments and Applications.

Level of responsibility: co-applicant

## 5. Distinctions and awards

- **2019** Nomination by Karlstad University for the Wallenberg Academy Fellows program.
- **2018** Nomination by the student union at Karlstad University for the best teacher award.
- **2007-2011** PhD full scholarship by Ministry of Science Research and Technology, Tehran Polytechnic, Iran.
- **2005** Outstanding Undergraduate Student in Mechanical Engineering with the Rank #1 in class, Received a full scholarship for master's programs in mechanical engineering outside of normal application and examination.
- **2005-2007** MSc full scholarship by Ministry of Science Research and Technology, Tehran Polytechnic, Iran.
- **2001** Total rank of 220 among 368404 participants of the nationwide university entrance exam, Received a full scholarship for undergraduate programs.
- **2001-2005** BSc full scholarship by Ministry of Science Research and Technology, Tehran Polytechnic, Iran.

## 6. Formal university pedagogical and management training

- **2017-2018** A course on "Supervising doctoral and licentiate students", Karlstad University, Sweden.
- **2016** A course on "How to Deliver a Lecture", Mathematical, Physical and Life Sciences Division, University of Oxford.
- **2014** Project management basics, Aalto University Professional Development, Finland.
- **2014** Project management best practices, Aalto University Professional Development, Finland.
- **2013** IPMA (International Project Management Association) Certification Preparation, Aalto University Professional Development, Finland.
- **2012-2014** Formal pedagogical trainings (29 credits), Strategic Support for Research and Education, Aalto University, Finland.

## 7. Supervision

- **2019-present** Supervisor of PhD students: Danial Molavitabrizi & Rhodel Bengtsson, Uppsala University, Sweden.
- **2019-present** Main supervisor of Bachelor theses (in total 3), Uppsala University, Sweden.
- **2012-2016** Instructor of PhD student: Saba Tahaei Yaghoubi, Aalto University, Finland.
- **2016-2019** Supervisor of Master theses (in total 8), Karlstad University, Sweden.
- **2018-2019** Training program on researcher development, offered by EU-funded Transpeer project organized by universities in Sweden, UK, Norway, and Portugal.

## 8. Publications

- 43 peer-reviewed journal papers & 26 conference presentations
- Google Scholar: <https://scholar.google.com/citations?user=fOnQMhgAAAAJ&hl=en>
- Researchgate: [https://www.researchgate.net/profile/Mahmoud\\_Mousavi](https://www.researchgate.net/profile/Mahmoud_Mousavi)

## 9. Other scientific merits

- Reviewer of the peer reviewed international journals (21 journals)
- COST Review Panels on Engineering and Technology, nominated by Sweden
- Session chair and organizer of mini- symposiums in international conferences (4 events)
- Member of program council for the Master program of Additive Manufacturing at Uppsala University
- Examiner of Doctoral thesis

**Publication lists: S. Mahmoud Mousavi (Dec 2021)**

➤ **Peer-reviewed journals**

- 1- Molavitabrizi, D., Ekberg, A., **Mousavi, S.M., 2021**, Computational model for low cycle fatigue analysis of lattice materials: Incorporating theory of critical distance with elastoplastic homogenization. *European Journal of Mechanics - A/Solids*.
- 2- El Dhaba A.R., **Mousavi, S.M., 2021**, Analysis of planes within reduced micromorphic model. *Scientific Report* 11:15537.
- 3- Molavitabrizi, D., **Mousavi, S.M., 2021**, Elasticity of Anisotropic Low-Density Lattice Materials. *ASME Journal of Engineering Materials and Technology* 143:021007-1
- 4- **Mousavi S.M., 2019**, Singularity-free defect mechanics for polar media, *Continuum Mechanics and Thermodynamics* 31:1883–1909.
- 5- Ouakad H.M., El-Borgi, S., **Mousavi S.M., Friswell M.I., 2018**, Static and Dynamic Response of CNT Nanobeam using Nonlocal Strain and Velocity Gradient Theory. *Applied Mathematical Modelling* 62:207–222.
- 6- Tahaei Yaghoubi S., Balobanova V., **Mousavi S.M., Niiranen J., 2018**, Variational formulations and isogeometric analysis for the dynamics of anisotropic gradient-elastic flexible and shear-deformable beams. *European Journal of Mechanics-A/Solids* 69:113–123.
- 7- Salvati E., Brandt L., Papadaki C, Zhang H, **Mousavi S.M., Wermeille D., Korsunsky A.M., 2018**, Nanoscale Structural Damage due to Focused Ion Beam Milling of Silicon. *Materials Letters* 213:346–349
- 8- Kaiyuan L., **Mousavi S.M., Hostikka S., 2017**, Char cracking of medium density fibreboard due to thermal shock effect induced pyrolysis shrinkage. *Fire Safety Journal* 91:165–173.
- 9- Tahaei Yaghoubi S., **Mousavi S.M., Paavola J., 2017**, Buckling of centrosymmetric anisotropic beam structures within strain gradient elasticity. *International Journal of Solids and Structures* 109:84–92.
- 10- Fernandes R., El-Borgi S., **Mousavi S.M., Reddy J.N., Mechmoum A., 2017**, Nonlinear size-dependent longitudinal vibration of carbon nanotubes embedded in an elastic medium. *Physica E: Low-dimensional Systems and Nanostructures* 88:18–25.
- 11- Ayatollahi M., Bagheri R., Nourazar M., Monfared M.M., **Mousavi S.M., 2017**, Analytic solutions of multiple moving cracks in an orthotropic layer bonded to an orthotropic FGM coating. *Applied Mathematics and Computation* 293: 394–403.
- 12- Bagheri R., Ayatollahi M., **Mousavi S.M., 2017**, Stress analysis of a functionally graded magneto-electro-elastic strip with multiple moving cracks. *Mathematics and Mechanics of Solids*, 22:304-323.
- 13- Tahaei Yaghoubi S., **Mousavi S.M., Paavola J., 2017**, Size effects on centrosymmetric anisotropic shear deformable beam structures. *Zeitschrift fuer Angewandte Mathematik und Mechanik* 97:586–601.
- 14- Sourki R., Ayatollahi M., Monfared M.M., **Mousavi S.M., 2016**, Multiple cracks in an elastic half-plane subjected to thermo-mechanical loading. *Iranian Journal of Mechanical Engineering Transactions of the ISME* 17(2):19-45.
- 15- Korsunsky A.M., Guenolé J, Salvati E., Sui T., **Mousavi S.M., Prakash A., Bitzek E., 2016**, Quantifying eigenstrain distributions induced by focused ion beam damage in silicon. *Materials Letters* 185:47-49.
- 16- **Mousavi S.M., Aifantis E.C., 2016**, Dislocation-based gradient elastic fracture mechanics for in-plane analysis of cracks. *International Journal of Fracture* 202(1):93-110.
- 17- **Mousavi S.M., Reddy J.N., Romanoff J., 2016**, Analysis of anisotropic gradient elastic shear deformable plates. *Acta Mechanica*, 227:3639-3656.
- 18- Fernandes R., **Mousavi S.M., El-Borgi S., 2016**, Free and Forced Vibration Nonlinear Analysis of a Nanobeam using Finite Strain and Velocity Gradients Theory. *Acta Mechanica* 227:2657–2670.

- 19- **Mousavi S.M., 2016**, Dislocation-based fracture mechanics within nonlocal and gradient elasticity of bi-Helmholtz type-Part I: Antiplane analysis. *International Journal of Solids and Structures* 87:222–235.
- 20- **Mousavi S.M., 2016**, Dislocation-based fracture mechanics within nonlocal and gradient elasticity of bi-Helmholtz type-Part II: Inplane analysis. *International Journal of Solids and Structures*, 92:105–120.
- 21- Monfared M.M., Ayatollahi M., **Mousavi S.M., 2016**, The mixed-mode analysis of a functionally graded orthotropic half-plane weakened by multiple curved cracks. *Archive of Applied Mechanics* 86:713–728.
- 22- **Mousavi S.M., Korsunsky A.M., 2015**, Non-singular antiplane fracture theory within nonlocal anisotropic elasticity. *Materials and Design*, 25:854–861.
- 23- **Mousavi S.M., Aifantis E.C., 2015**, A Note on Dislocation-based Mode III Gradient Elastic Fracture Mechanics. *Journal of the Mechanical Behavior of Materials* 24:115–119.
- 24- **Mousavi S.M., Paavola J., Reddy J.N., 2015**, Variational approach to dynamic analysis of third-order shear deformable plates within gradient elasticity. *Meccanica* 50:1537-1550.
- 25- **Mousavi S.M., Lazar M., 2015**, Distributed dislocation technique for cracks based on non-singular dislocations in nonlocal elasticity. *Engineering Fracture Mechanics*, 136:79–95.
- 26- **Mousavi S.M., Niiranen J., Niemi A.H., 2015**, Differential cubature method for gradient-elastic Kirchhoff plates. *Journal of Structural Mechanics* 48:164–180.
- 27- Bagheri R., Ayatollahi M., **Mousavi S.M., 2015**, Analytical solution of multiple moving cracks in a functionally graded piezoelectric strip, *Applied Mathematics and Mechanics* 36:777–792.
- 28- **Mousavi S.M., 2015**, Dislocation-based fracture analysis of functionally graded magneto-electro-elastic solids. *Zeitschrift fuer Angewandte Mathematik und Mechanik* 95:1501–1513.
- 29- Tahaei Yaghoubi S., **Mousavi S.M., Paavola J., 2015**, Strain and velocity gradient theory for higher-order shear deformable beams. *Archive of Applied Mechanics*, 85:877–892.
- 30- Bagheri R., Ayatollahi M., **Mousavi S.M., 2015**, Analysis of cracked piezoelectric layer with imperfect non-homogeneous orthotropic coating, *International Journal of Mechanical Sciences*. 93:93–101.
- 31- **Mousavi S.M., Paavola J., 2015**, Analysis of a cracked concrete containing an inclusion with inhomogeneously imperfect interface, *Mechanics Research Communications* 63:1-5.
- 32- **Mousavi S.M., Paavola J., 2014**, Analysis of plate in second gradient elasticity, *Archive of Applied Mechanics* 84:1135–1143.
- 33- **Mousavi S.M., Paavola J., Baroudi D., 2014**, Distributed nonsingular dislocation technique for cracks in strain gradient elasticity, *Journal of the Mechanical Behavior of Materials* 23:47-58.
- 34- **Mousavi S.M., Paavola J., Baroudi D., 2014**, Cracks in strain gradient elasticity: distributed dislocation technique, *Procedia Materials Science*: 3:77–82.
- 35- Baghestani A.M., Fariborz S.J., **Mousavi S.M., 2014**, Low-Frequency Free Vibration of Rods with Finite Strain, *Journal of Applied Nonlinear Dynamics* 3:85–93.
- 36- **Mousavi S. M., Paavola J., 2013**, Analysis of functionally graded magneto-electro-elastic layer with multiple cracks, *Theoretical and Applied Fracture Mechanics*, 66:1–8.
- 37- **Mousavi S.M., Paavola J., 2013**, Analysis of cracked functionally graded piezoelectric strip, *International Journal of Solids and Structures* 50:2449–2456.
- 38- **Mousavi S.M., Fariborz S.J., Paavola J., 2012**, Screw dislocation in functionally graded layers with arbitrary gradation, *Journal of Structural Mechanics* 45:125–132.
- 39- **Mousavi S.M., Fariborz S.J., 2012**, Anti-plane elastodynamic analysis of cracked graded orthotropic layers with viscous damping, *Applied Mathematical Modelling* 36:1626–1638.
- 40- **Mousavi S.M., Fariborz S.J., 2012**, Free vibration of a rod undergoing finite strain, *Journal of Physics: Conference Series* 382:012011.
- 41- **Mousavi S.M., Fariborz S.J., 2011**, Propagation of Anti-plane Shear Waves in a Cracked Graded Strip with Viscous Damping, *Procedia Engineering* 10:792–797.
- 42- **Mousavi S.M., 2011**, Differential cubature method for static solution of laminated shells of revolution with mixed boundary conditions, *Key Engineering Materials* 471:1005–1009.
- 43- **Mousavi S.M., Aghdam M.M., 2009**, Static bending analysis of Laminated cylindrical panels with various boundary conditions using the differential cubature method, *Journal of Mechanics of Materials and Structures* 4:509–521.