Curriculum Vitae et Studiorum

Michele Curatolo

Position

Mar. 2019-Present	Post-Doc at Structural and Geotechnical Engineering Department, Sapienza University of Rome. Research project: Morphing of soft elastic anisotropic thin structures Tutor: Prof. P. Nardinocchi

Fields of Interest

My current research involves the investigation of shape changes in soft elastic thin structures. My primary interest is on innovative topics such as active gels, shape-shifting mechanisms and smart materials. Other fields of interest include meta-hydrogels and problems of fluid-solid interaction. I work among engineering, mathematics and physics and I am interested in analytical, numerical methods and occasionally experiments.

Education

Oct. 2015-Mar. 2019	Ph.D. in Civil Engineering, Roma TRE University, Thesis: Smart Materials as Energy Transducers Advisors: Dr. P. Prestininzi & Prof. L. Teresi
Oct. 2013-Oct. 2015	Master's Degree in Civil Engineering: Protection from Natural Hazards, Roma TRE University, 110/110 *cum laude.* Thesis: Fluid-structure interaction for an elastic beam Advisor: Prof. L. Teresi
Oct. 2010-Dec. 2013	Bachelor's Degree in Civil Engineering, Roma TRE University, 106/110. Thesis: Elastic waves in anisotropic materials Advisor: Prof. L. Teresi

Appointments & Visiting Positions

Fall 2019	Visiting at Virginia Polytechnic Institute and State University, USA. Research project: mathematical modeling of the material response and active biological tissue. Host: Prof. Raffaella De Vita
Fall 2018	Visiting at Technical University of Dresden, Germany. Research project: numerical investigation on the electro-chemo-mechanical model for thin Nafion membranes employed in batteries and fuel cells. Host: Prof. Thomas Wallmersperger
Fall 2017	Visiting at Technical University of Dresden, Germany. Research project: numerical investigation on the interaction between mechanical and electrochemical field within an electrochemical cell. Host: Prof. Thomas Wallmersperger
Apr.-Jul. 2017	Visiting scholarship at Boston University, USA. Research project: experiments and simulations on swelling and adhesion of gels. Advisor: Prof. D. P Holmes

Participation to National and International Research Projects as Principal Investigator (PI) and Member (I)

PI: Research Project Grant, "Progetti per Avvio alla Ricerca - Tipo 2", Sapienza University of Rome (€ 3150,00), "Morphing of soft elastic anisotropic thin structures", protocol number: AR21916B698F2037, 2019.

I: Research Project Grant, "Progetti di Ricerca (Piccoli Medi) - Progetti Medi", Sapienza University of Rome, (€ 15000,00), "Mechanical insights into volume overloaded left heart: two-chamber diastolic-systolic functional diseases", protocol number: RM1181642B2FDE85, 2018.

I: Research Project Grant, "great!$_{ipid4all}$", Technical University of Dresden Graduate Academy (€ 5216,80), "numerical investigation on the electro-chemo-mechanical model for thin Nafion membranes employed in batteries and fuel cells", protocol number: 2018_84, 2018.

I:Research Project Grant, "Giovani Ricercatori", INdAM (€ 2500,00), "Attuatori idrogel", protocol number: U-UFMBAZ-2018-000356, 2018.

I: Research Project Grant, "great!$_{ipid4all}$", Technical University of Dresden Graduate Academy (€ 3761,44), "numerical investigation on the interaction between mechanical and electrochemical field within an electrochemical cell", protocol number: 2017_74, 2017.

I: Research Project Grant, "Progetti di Ricerca Grandi - Progetti Grandi", Sapienza University of Rome, (€ 40000,00), "Mechanics of Soft Fibered Active Materials", protocol number: RG11715C7CE2C1C4, 2017.

I: Research Project Grant, "Giovani Ricercatori", INdAM (€ 3000,00), "Mathematical modeling of bio-hybrid and bio-inspired soft robots", protocol number: U2016/000191, 2016.

Awards and Honours

- Merit Grant for Maximum Score in the Academic Title, given by Fiumicino City (€ 1000,00), 2016.

- "Best Paper Award" for the paper *The Virtual Aquarium: Simulation of Fish Swimming* presented at the European COMSOL Conference, Grenoble, France, October 2015.

- ”Best Poster Award” (popular choice), for the poster *The Virtual Aquarium: Simulation of Fish Swimming* presented at the European COMSOL Conference, Grenoble, France, October 2015.

Research Activity

A short description

My primary research focus is on morphing and shape-shifting in thin structures which are elastic and soft (see articles [2, 3, 7]). What is realized is a power leverage: the shift from a low power process to a high power process as a consequence of an instability mechanism which can be controlled through the design of anisotropy and/or inhomogeneity in the material itself. Within this context, the goal of my research is to create new materials and devices which exhibit shape-shifting mechanisms using consistent mathematical models. At the moment, I am working also on diffusion and swelling in hydrogels (see [4, 8, 9]). This latter research line, includes: the design of innovative meta-hydrogels (hydrogels with unusual properties given by internal structure rather than composition) (see [6]), the prediction of hydrogels shape after swelling or de-hydration (see, [2, 3]), the study of diffusion and instabilities in gel micro-capsules and the investigation of active gels using a mathematical model which couples mechanics, diffusion and active contraction or growth (see [1, 10]). Finally, I work also on multi-physics problems such as bending of piezoelectric materials and fluid-solid interactions (see [5, 11]).

Summary of Scientific Achievements

Articles in International Journals

1. **M. Curatolo**, P. Nardinocchi, L. Teresi.

   Dynamics of active swelling in contractile polymer gels. *Journal of the Mechanics and Physics of Solids*, vol. 135, pp. 103807, (2020).

   Doi:10.1016/j.jmps.2019.103807

2. D. Battista, **M. Curatolo**, P. Nardinocchi.

   Enforcing shaping of thin gel sheets by anisotropic swelling. *Mechanics of Materials*, vol. 139, pp. 103199, (2019).

   Doi:10.1016/j.mechmat.2019.103199

3. D. Battista, **M. Curatolo**, P. Nardinocchi.

   Swelling-induced eversion and flattening in naturally curved gel beams. *International Journal of Mechanical Sciences*, vol. 161-162, pp. 105071, (2019).

   Doi:10.1016/j.ijmecsci.2019.105071

4. **M. Curatolo**, P. Nardinocchi, L. Teresi, D. P. Holmes.

   Swelling effects on localized adhesion of an elastic ribbon. *Proceedings of the Royal Society A*, vol. 475, pp. 20190067, (2019).

   Doi:10.1098/rspa.2019.0067

5. **M. Curatolo**, M. La Rosa, P. Prestininzi.

   On the validity of plane state assumptions in the bending of bimorph piezoelectric cantilevers. *Journal of Intelligent Material Systems and Structures*, vol. 30(10), pp. 1508–1517, (2019).

   Doi:10.1177/1045389X19835959

6. **M. Curatolo**.

   Effective negative swelling of hydrogel-solid composites. *Extreme Mechanics Letters*, vol. 25, pp. 46-52, (2018).

   Doi:10.1016/j.eml.2018.10.010

7. **M. Curatolo**, P. Nardinocchi.

   Swelling-induced bending and pumping in homogeneous thin sheets. *Journal of Applied Physics*, vol. 124(8), pp. 085108, (2018).

   Doi:10.1063/1.5043580

8. **M. Curatolo**, P. Nardinocchi, L. Teresi.

   Driving water cavitation into a hydrogel cavity. *Soft Matter*, vol.14, pp. 2310-2321, (2018).

   Doi:10.1039/C8SM00100F

9. **M. Curatolo**, P. Nardinocchi, E. Puntel, L. Teresi.

   Transient instabilities in the swelling dynamics of a hydrogel sphere. *Journal of Applied Physics*, vol. 122(14), pp. 145109, (2017).

   Doi:10.1063/1.5007229

10. **M. Curatolo**, S. Gabriele, L. Teresi.

    Swelling and Growth: a Constitutive Framework for Active Solids. *Meccanica*, vol. 52(14), pp. 3443-3456, (2017).

    Doi: 10.1007/s11012-017-0629-x.

11. **M. Curatolo**, L. Teresi.

    Modeling and Simulation of Fish Swimming with Active Muscles. *Journal of Theoretical Biology*, vol. 409, pp. 18-26, (2016).

    Doi: 10.1016/j.jtbi.2016.08.025.

Contributions to Books and Conferences Proceedings

1. **M. Curatolo**, M. La Rosa, P. Prestininzi.

   Energy harvesting in a fluid flow using piezoelectric materials, Proceedings of the European COMSOL Conference, Lausanne, Switzerland, (2018).

2. **M. Curatolo**, L. Teresi.

   The Virtual Aquarium: Simulation of Fish Swimming, Proceedings of the European COMSOL Conference, Grenoble, France, (2015).

Conferences, Meetings and Workshops Presentations

1. 56^{th} Society of Engineering Science (SES) Technical Meeting, St Louis, USA, 13 October - 15 October 2019.
   Talk: Instabilities driven by controlled release in spherical microcapsules.
2. 24^{th} AIMETA (Italian Association of Theoretical and Applied Mechanics) Conference, Rome, Italy, 15 September - 19 September 2019.
   Invited talk: Elasto-active instabilities of spherical shells.

3. Meeting at the Technical University of Dresden, Germany, 11 December 2018.
   Invited talk: Soft Active Gels modeling, numerical simulations and new perspectives
4. European COMSOL Conference, Lausanne, Switzerland, 22 October - 24 October 2018.
   Talk: Energy Harvesting in a Fluid Flow Using Piezoelectric Materials.
   Poster: Energy harvesting in a Fluid flow using piezoelectric materials.
5. 55^{th} Society of Engineering Science (SES) Technical Meeting, Madrid, Spain, 10 October - 12 October 2018.
   Invited talk: Effective negative swelling of hydrogel-solid composites.
6. Solvay Workshop on "Mechanics of slender structures in physics, biology and engineering: from failure to functionality", Université Libre de Bruxelles, Brussels, Belgium, 27 August - 29 August 2018.
   Invited poster: Swelling and adhesion of elastic solids.
7. 10^{th} European Solid Mechanics Conference (ESMC), Bologna, Italy, 2 July - 6 July 2018.
   Talk: High-power mechanics in gel structures driven by physics.
8. Ph.D. Examination, Roma TRE University, Roma, Italy, 9 November 2017.
   Poster: Fluid-Solid Interaction with Applications on Energy Harvesting and Active Solids.
9. INdAM Meeting "Mathematical Physics of Living Systems", Cortona, Italy, 27 August - 2 September 2017.
   Invited talk: Modeling of Carangiform Swimming.
10. Ph.D. Examination, Roma TRE University, Roma, Italy, 14 November 2016.
    Poster: Energy Harvesting and Active Solids in Multiphysics Problems.
11. Summer school in Physics and Mechanics of Soft Complex Materials, Cargese Institute of Scientific Studies, Cargese, France, 8 August - 20 August 2016.
    Poster: A Simple Model for Volume Transitions in Slide-Ring Gels,
12. European COMSOL Conference, Grenoble, France, 14 October - 16 October 2015.
    Talk: The Virtual Aquarium: Simulations of Fish Swimming.
    Poster: The Virtual Aquarium: Simulations of Fish Swimming.

Short Advanced Courses, Schools and Workshops

- Summer school of Mathematical Physics, INdAM, Ravello, Italy, 10-22 September 2018.

- Course "Non-linear Propagation and Non-equilibrium Thermodynamics", Catholic University of the Sacred Heart, Brescia, Italy, 23-25 January 2017.

- COMSOL Training Courses, Structural Analysis, Thermal Analysis, Computational Fluid Dynamics, Roma, Italy, 25-27 October 2016.

- Summer school in Multiscale Bioengineering: from Molecules to organs (μMBioEng), University of Perugia, Perugia, Italy, 6-10 June 2016.

- Course "Introduction to geostatistical analysis, with applications using Mathematica", Roma TRE University, Italy, May-June 2016.

- Seminars series "Mechanics and Mathematics of (soft) Materials and Structures", Sapienza University, Roma, Italy, March-July 2016.

- Course "Numerical solution of research problems in Civil Engineering", Roma TRE University, Roma, Italy, February-March 2016.

- Course "Nonlinear Elasticity for Rubber-like Materials and Soft Tissues", Catholic University of the Sacred Heart, Brescia, Italy, 1-3 February 2016.

- Workshop "Physics and Mathematics of Materials: current insights - on the occasion of the $75th$ birthday of Paolo Podio-Guidugli", Gran Sasso Science Institute, Aquila, Italy, 20 January - 22 January 2016.

Skills, Qualifications and Scientific Experience

- Very good knowledge of the Finite Element Method software Comsol Multiphysics

- Very good knowledge of Wolfram Mathematica

- Good knowledge of Matlab

- Very good knowledge of Latex

- Expert in modeling multi-physics non-linear problems in continuum mechanics

Languages

English: Fluent
Italian: Mothertongue

Other Interests and Activities

I am interested in many science topics such as astronomy, technology and biology. During my free time I like to play tennis and to do some jogging occasionally. I enjoy also to watch movies and listen to music.