

## Curriculum Vitae et Studiorum

Michele Curatolo

### Personal Data

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### Position

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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

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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

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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

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- 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)

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**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

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- 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

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### 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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<sup>th</sup> 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 ( $\mu$ MBioEng), 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

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- 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

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English: Fluent  
Italian: Mothertongue

## Other Interests and Activities

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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.