

Hyunwoo Yuk

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RESEARCH FOCUSES

- Soft materials for human health
- Wet adhesion and bioadhesive technologies
- Hydrogel bioelectronics
- 3D printing of soft functional materials
- Soft active materials and robots

DEGREE & EDUCATION

Ph.D. in Mechanical Engineering **Jun 2016 - Dec 2020**
Massachusetts Institute of Technology, Cambridge, MA, United States
(Thesis: Wet Adhesion and Bioadhesive Technology)

M.S. in Mechanical Engineering **Sep 2014 - Jun 2016**
Massachusetts Institute of Technology, Cambridge, MA, United States
(Thesis: Tough Wet Adhesion of Hydrogel on Various Materials)

B.S. in Mechanical Engineering **Feb 2007 - Feb 2014**
Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Republic of Korea
Graduation with *Summa Cum Laude*
(Note: Military Service during June 2011 - June 2013)

AWARDS & HONORS

- **Collegiate Inventors Competition Graduate Winner**, National Inventors Hall of Fame, 2020
- **BMES Student Design and Research Award**, Biomedical Engineering Society, 2019
- **de Florez Graduate Design Award - 1st Place**, Department of Mechanical Engineering, MIT, 2019
- **Wunsch - Outstanding Graduate Research Award**, Department of Mechanical Engineering, MIT, 2019
- **MRS Graduate Student Award - Gold**, Materials Research Society, 2019
- **Peebles Award**, The Adhesion Society, 2019
- **Forbes 30 Under 30 2019: Science**, Forbes, 2018
- **Face of the Year**, Samsung Scholarship, 2018
- **MRS Graduate Student Award - Silver**, Materials Research Society, 2018
- **2015 Samsung Scholarship**, Samsung Scholarship Foundation, 2015
- **Summa Cum Laude**, KAIST, 2014
- **2013 Samsung Scholarship**, Samsung Scholarship Foundation, 2013

- **Outstanding Achievement *Cum Laude* Award**, Department of Mechanical Engineering, KAIST, 2010
- **Outstanding Achievement *Cum Laude* Award**, Department of Mechanical Engineering, KAIST, 2009
- **Korean Governmental Scholarship**, KAIST, 2007-2010

RESEARCH EXPERIENCE

Research Scientist **Jan 2021 - Present**
Department of Mechanical Engineering, MIT

Graduate Research Assistant **Sep 2014 - Jan 2021**
Zhao Laboratory (PI: Prof. Xuanhe Zhao), MIT

- Hydrogel technologies human-machine interface
- Wet adhesion and bioadhesive technologies
- Hydrogel bioelectronics
- 3D printing of advanced soft materials
- Soft active materials and robots

Undergraduate Researcher **Jun 2009 - Apr 2011**
Intelligent Systems & Neurobotics Laboratory (PI: Prof. Sungho Jo), KAIST
Soft Biomechanics & Biomaterials Laboratory (PI: Prof. Jennifer H. Shin), KAIST

- Design and control of small crawling robot inspired by the motion and the biological structure of the nematode *Caenorhabditis elegans* (*C.elegans*)
- Development of small linear actuators mimicking biological muscle using thermal shape memory alloy (SMA)
- Development of simple CPG patterned motion control mechanism inspired by the muscular activations of *C.elegans* during locomotion

Undergraduate Research Program (URP) **Dec 2009 - May 2010**
Mechatronics, Systems and Control Laboratory (PI: Prof. Kyungsoo Kim), KAIST

- Dynamic analysis and computational simulation on rotating mass control (RMC) for floating body stabilization aimed at mobile harbor applications

PROFESSIONAL ACTIVITIES

Project management & mentoring

Postdoctoral fellows

- **Jingjing Wu** | Translational bioadhesives | Jingjing Wu#, Hyunwoo Yuk#* et al., An off-the-shelf bioadhesive patch for sutureless repair of gastrointestinal defects, *Science Translational Medicine*, in revision (2021)
- **Jue Deng** | Electrical bioadhesive interface | Jue Deng#, Hyunwoo Yuk# et al., Electrical bioadhesive interface for bioelectronics, *Nature Materials* **20**, 229-236 (2021)
- **Xiaoyu Chen** | Smart hydrogel platforms | Xiaoyu Chen#, Hyunwoo Yuk# et al., Instant tough bioadhesive with triggerable benign detachment, *PNAS* **117**, 15497-15503 (2020)

- **Akihisa Inoue** | Strong conducting polymer adhesion | Akihisa Inoue#, Hyunwoo Yuk#, et al., Strong adhesion of wet conducting polymers on diverse substrates, *Science Advances* **6**, eaay5394 (2020)
- **Baoyang Lu** | High performance PEDOT:PSS hydrogels | Baoyang Lu#, Hyunwoo Yuk#, et al., Pure PEDOT:PSS hydrogels, *Nature Communications* **10**, 1043 (2019)
- **Yan Yu** | Hydrogel skin for medical devices | Yan Yu#, Hyunwoo Yuk# et al., Multifunctional hydrogel skins on diverse polymers with arbitrary shapes, *Advanced Materials* **31**, 1807101 (2019)

Graduate students

- **Heejung Roh** | Programmable bioadhesive for diabetic wound healing | Georgios Theocharidis#, Hyunwoo Yuk#*, Heejung Roh# et al., Strain-programmable patch for diabetic wound healing, *Science Translational Medicine*, under review (2021)
- **Sarah Wu** | Minimally invasive bioadhesive patch | Sarah J. Wu#, Hyunwoo Yuk#*, et al., A Multifunctional origami patch for minimally invasive tissue sealing, *Advanced Materials* **33**, 2007667 (2021)
- **Xinyu Mao** | Hemostatic bioadhesive paste | Hyunwoo Yuk*, Jingjing Wu, Xinyu Mao et al., Barnacle-glue-inspired paste for rapid and coagulation-independent haemostatic sealing, *Nature Biomedical Engineering*, in press (2021)
- **Yoonho Kim** | 3D printing of magnetic soft active materials | Yoonho Kim#, Hyunwoo Yuk# et al., Printing ferromagnetic domains for untethered fast-transforming soft materials, *Nature* **558**, 274-279 (2018)
- **Xinyue Liu** | 3D printing of living materials | Xinyue Liu#, Hyunwoo Yuk# et al., 3D printing of living responsive materials and devices, *Advanced Materials* **30**, 1704821 (2018)

Undergraduate & K-12 students

- **William Pan** (currently in Stanford University) | Bioadhesive devices | William Pan*, Beverly Matsuda, Hyunwoo Yuk*, Biocompatible hydrogel ostomy adhesive, *Medical Devices & Sensors* **3**, e10132 (2020)
- **Manuel La Torre** | 3D printing of bioelectronic devices
- **Charles Ezeugwu** (currently in Raytheon) | 3D printing-based programmable thermal conductivity in elastomers
- **Pelkins Ajanoh** (currently in Harvard Business School) | 3D printing of soft robotic hands
- **Jane Im** (currently in Michigan University) | 3D printing of soft robotic hands
- **Rachel Adenekan** (currently in Stanford University) | Conductive hydrogels for neural interfacing

Peer-review for scientific journals (selected list)

- NPG journals (*Nature*, *Nature Materials*, *Nature Biomedical Engineering*, *Nature Communications*)
- AAAS journals (*Science*, *Science Advances*, *Science Robotics*)
- *Proceedings of National Academy of Science*
- Wiley journals (*Advanced Materials*, *Advanced Functional Materials*, *Advanced Intelligent Materials*)
- Elsevier journals (*Extreme Mechanics Letter*, *Biomaterials*)
- ACS journals (*ACS Applied Materials & Interfaces*)

INVITED TALKS & SEMINARS

- Versatile Hydrogel Technologies: Adhesive, Conductive, and Printable Hydrogels, Mechanical Engineering Faculty Seminar, Yonsei University, May 2021
- Soft Materials for Tough Problems: Hydrogel Technologies for Biomedical Applications, Biomedical Engineering and Physiology (BMEP) Seminar, Mayo Clinic, April 2021
- Soft Materials for Tough Problems: Hydrogel Technologies for Biomedical Applications, Graduate School of Medical Science and Engineering Seminar, KAIST, April 2021
- Bedside-to-Bench-to-Bedside: Ongoing Journey on Bioadhesive Technology Translation, The Martlets Society, Feb 2021
- Sticky Solutions for Sticky Problems: Translational Wet Adhesion Technologies, EASF Webinar, Jun 2020
- Soft materials for hard problems in human-machine interfacing, Mechanical Engineering Seminar, KAIST, Jul 2019
- Soft materials platform for living materials and devices, DGIST, Jul 2017
- Tough wet adhesion of hydrogels, IRG meeting, MIT, Dec 2015
- Multi-scale multi-mechanism design of tough and bioactive hydrogels: Theory, experiment and application, Invited graduate student seminar, University of Connecticut, Apr 2015

PUBLICATIONS

PEER-REVIEWED JOURNALS

Notes: # indicates equally contributing authors. * indicates the corresponding author(s).

First/Corresponding Authored Papers

including 2 in *Nature* | 2 in *Nature Materials* | 1 in *Nature Biomedical Engineering* | 5 in *Nature Communications* | 1 in *Science Advances* | 5 in *Advanced Materials* | 2 in *PNAS*

1. G. Theodoridis#, **H. Yuk##***, H. Roh#, L. Wang#, I. Mezghani, J. Wu, A. Kafanas, L. Chen, C. F. Guo, N. Jayaswal, X.-L. Katopodi, C. S. Nabzdyk, I. S. Vlachos, A. Veves*, X. Zhao*, Strain-programmable patch for diabetic wound healing, *Science Translational Medicine*, under review (2021) ([bioRxiv pre-print](#))
2. J. Wu#, **H. Yuk##***, T. L. Sarrafian#, L. G. Griffiths, C. S. Nabzdyk*, X. Zhao*, An off-the-shelf bioadhesive patch for sutureless repair of gastrointestinal defects, *Science Translational Medicine*, in revision (2021) ([bioRxiv pre-print](#))
3. **H. Yuk##***, J. Wu#, X. Mao, C. V. Verela, E. T. Roche, C. S. Nabzdyk*, X. Zhao*, Rapid and coagulation-independent haemostatic sealing by a paste inspired by barnacle glue, *Nature Biomedical Engineering*, in press (2021) ([bioRxiv pre-print](#))
4. S. Park#, **H. Yuk#**, R. Zhao, Y. S. Yim, E. W. Woldegebriel, J. Kang, A. Canales, Y. Fink, G. B. Choi, X. Zhao*, P. Anikeeva*, Adaptive, multifunctional hydrogel hybrid probes for long-term sensing and modulation of neural activity, *Nature Communications* **12**, 3435 (2021)
5. S. Wu#, **H. Yuk##***, J. Wu, C. S. Nabzdyk, X. Zhao*, A multifunctional origami patch for minimally invasive tissue sealing, *Advanced Materials* **33**, 2007667 (2021) (*selected as cover*)
6. W. Pan*, B. Matsuda, **H. Yuk***, Biocompatible hydrogel ostomy adhesive, *Medical Devices & Sensors* **3**, e10132 (2020)

7. J. Deng#, **H. Yuk#**, C. E. Varela, J. Wu, X. Chen, E. T. Roche, C. F. Guo*, X. Zhao*, Electrical bioadhesive interface for bioelectronics, *Nature Materials* **20**, 229-236 (2021)
8. X. Chen#, **H. Yuk#**, J. Wu, C. S. Nabzdyk, X. Zhao*, Instant tough bioadhesive with triggerable benign detachment, *Proceedings of National Academy of Science* **117**, 15497-15503 (2020)
9. **H. Yuk**, B. Lu, S. Lin, K. Qu, J. Xu, J. Luo, X. Zhao*, 3D printing of conducting polymers, *Nature Communications* **11**, 1604 (2020)
10. A. Inoue#, **H. Yuk#**, B. Lu, X. Zhao*, Strong adhesion of wet conducting polymers on diverse substrates, *Science Advances* **6**, eaay5394 (2020)
11. **H. Yuk**, C. E. Varela, C. S. Nabzdyk, X. Mao, R. F. Padera, E. T. Roche, X. Zhao*, Dry double-sided tape for adhesion of wet tissues and devices, *Nature* **575**, 169-174 (2019)
12. B. Lu#, **H. Yuk#**, S. Lin, N. Jian, K. Qu, J. Xu, X. Zhao*, Pure PEDOT:PSS hydrogels, *Nature Communications* **10**, 1043 (2019)
13. Y. Yu#, **H. Yuk#**, G. A. Parada#, Y. Wu, X. Liu, C. S. Nabzdyk, K. Youcef-Toumi, J. Zang, X. Zhao*, Multifunctional hydrogel skins on diverse polymers with arbitrary shapes, *Advanced Materials* **31**, 1807101 (2019) (*selected as cover*)
14. **H. Yuk**, B. Lu, X. Zhao*, Hydrogel bioelectronics, *Chemical Society Reviews* **48**, 1642-1667 (2019) (*review article*)
15. Y. Km#, **H. Yuk#**, R. Zhao#, S. Chester, X. Zhao*, Printing ferromagnetic domains for untethered fast-transforming soft materials, *Nature* **558**, 274-279 (2018) (*selected as cover*)
16. X. Liu#, **H. Yuk#**, S. Lin, G. A. Parada, T.-C. Tang, E. Tham, C. Fuente, T. K. Lu, X. Zhao*, 3D printing of living responsive materials and devices, *Advanced Materials* **30**, 1704821 (2018) (*selected as cover*)
17. **H. Yuk**, X. Zhao*, A new 3D printing strategy by harnessing deformation, instability, and fracture of viscoelastic inks, *Advanced Materials* **30**, 1704028 (2018) (*selected as cover*)
18. T. Zhang#, **H. Yuk#**, S. Lin, G. A. Parada, X. Zhao*, Tough and tunable adhesion of hydrogels: experiments and models, *Acta Mechanica Sinica* **33**, 543-554 (2017)
19. X. Liu#, T.-C. Tang#, E. Tham#, **H. Yuk#**, S. Lin, T. K. Lu*, X. Zhao*, Stretchable living materials and devices with hydrogel-elastomer hybrids hosting programmed cells, *Proceedings of National Academy of Science* **114**, 2200-2205 (2017)
20. **H. Yuk**, S. Lin, C. Ma, M. Takaffoli, N. Fang, X. Zhao*, Hydraulic hydrogel actuators and robots optically and sonically camouflaged in water, *Nature Communications* **8**, 14230 (2017)
21. **H. Yuk**, T. Zhang, G. A. Parada, X. Liu, X. Zhao*, Skin-inspired hydrogel-elastomer hybrids with robust interfaces and functional microstructures, *Nature Communications* **7**, 12028 (2016)
22. S. Lin#, **H. Yuk#**, T. Zhang#, H. Koo, C. Yu, X. Zhao*, Stretchable hydrogel electronics and devices, *Advanced Materials* **28**, 4497-4505 (2016)
23. **H. Yuk**, T. Zhang, S. Lin, G. Parada, X. Zhao*, Tough bonding of hydrogels to diverse non-porous surfaces, *Nature Materials* **15**, 190-196 (2016)
24. **H. Yuk**, D. Kim, H. Lee, S. Jo*, J. H. Shin*, Shape memory alloy-based small crawling robots inspired by *C.elegans*, *Bioinspiration and Biomimetics* **6**, 046002 (2011)

Contributing Authored Papers

25. X. Zhao*, X. Chen#, **H. Yuk**#, S. Lin#, X. Liu, G. Parada, Soft materials by design: Unconventional polymer networks give extreme properties, *Chemical Reviews* **212**, 4309–4372 (2021) (2021)
26. T.-C. Tang*, E. Tham, X. Liu, K. Yell, A. J. Rovner, **H. Yuk**, C. de la Fuente-Nunez, F. J. Isaacs, X. Zhao*, T. K. Lu*, Hydrogel-based biocontainment of bacteria for continuous sensing and computation, *Nature Chemical Biology* **17**, 724-731 (2021)
27. C. Park, Y. Fan, G. Hager, **H. Yuk**, M. Singh, A. Rojas, A. Hameed, M. Saeed, N. V. Vasilyev, T. W. J. Steele, X. Zhao, C. T. Nguyen* and E. T. Roche*, An organosynthetic dynamic heart model with enhanced biomimicry guided by cardiac diffusion tensor imaging, *Science Robotics* **5**, eaay9106 (2020)
28. X. Mao, **H. Yuk**, X. Zhao*, Hydration and swelling of dry polymers for wet adhesion, *Journal of the Mechanics and Physics of Solids* **137**, 103863 (2020)
29. X. Liu#, C. Steiger#, S. Lin#, G. A. Parada, J. Liu, H. F. Chan, **H. Yuk**, N. V. Phan, J. Collins, S. Tamang, G. Traverso, X. Zhao*, Ingestible hydrogel device, *Nature Communications* **10**, 493 (2019)
30. S. Lin#, X. Liu#, J. Liu#, **H. Yuk**, H.-C. Loh, G. A. Parada, C. Settens, J. Song, A. Masic, G. H. McKinley, X. Zhao*, Anti-fatigue-fracture hydrogels, *Science Advances* **5**, eaau8528 (2019)
31. R. Zhao, S. Lin, **H. Yuk**, X. Zhao*, Kirigami enhancing film adhesion: mechanism and applications to Kirigami wearables, *Soft Matter* **14**, 2515-2525 (2018)
32. S. Lin, Y. Mao, **H. Yuk**, X. Zhao*, Material-stiffening suppresses elastic fingering and fringe instabilities, *International Journal of Solids and Structures* **139**, 96-104 (2018)
33. G. A. Parada, **H. Yuk**, X. Liu, A. Hsieh, X. Zhao*, Impermeable robust hydrogels via hybrid lamination, *Advanced Healthcare Materials* **6**, 1700520 (2017)
34. S. Lin#, T. Cohen#, T. Zhang#, **H. Yuk**, R. Abeyaratne, X. Zhao*, Fringe instability in constrained soft elastic layers, *Soft Matter* **12**, 8899-8906 (2016)
35. J. Guo, X. Liu, N. Jiang, A. K. Yetisen, **H. Yuk**, C. Yang, A. Khademhosseini, X. Zhao, S-H. Yun*, Highly stretchable, strain sensing hydrogel optical fibers, *Advanced Materials* **28**, 10244-10249 (2016)
36. T. Zhang#, S. Lin#, **H. Yuk**, X. Zhao*, Predicting fracture energies and crack-tip fields of soft tough materials, *Extreme Mechanics Letters* **4**, 1 (2015)

PEER-REVIEWED CONFERENCE PROCEEDINGS

1. **H. Yuk**, J. H. Shin, S. Jo*, Design and control of thermal SMA based small crawling robot mimicking *C.elegans*, Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Taipei, Taiwan, Oct 2010 (doi: [10.1109/IROS.2010.5651043](https://doi.org/10.1109/IROS.2010.5651043))

PATENTS

1. **H. Yuk**, X. Zhao, H. Roh, A. Veves, G. Theocharidis, Shape memory adhesive materials for diabetic wound healing, U.S. Application No. 63/148,901
2. **H. Yuk**, H. Roh, X. Zhao, Hydration-based shape memory adhesive materials and methods of making, U.S. Application No. 63/148,874

3. **H. Yuk**, S. Wu, C. S. Nabzdyk, X. Zhao, Bioadhesive materials and minimally invasive methods for adhering tissues with bioadhesive materials, U.S. Application No. 63/091,105
4. **H. Yuk**, S. Wu, X. Zhao, Anti-fouling tissue adhesive patch, U.S. Application No. 63/091,076
5. **H. Yuk**, X. Chen, X. Zhao, Adhesive material with triggerable on-demand detachment, U.S. Application No. 63/034,644
6. **H. Yuk**, X. Mao, C. S. Nabzdyk, X. Zhao, Body fluid resistant tissue adhesives, US 2021/0163797
7. **H. Yuk**, X. Zhao, Dry double-sided tape for instant tough bonding of wet tissues and devices, US 2020/0353120
8. **H. Yuk**, A. Inoue, X. Zhao, Strong adhesion of conducting polymers on diverse substrates, US 2020/0377677
9. B. Lu, **H. Yuk**, X. Zhao, Pure PEDOT:PSS hydrogels with extraordinary electrical, mechanical, and swelling properties, US 2020/0299466
10. **H. Yuk**, Y. Kim, X. Zhao, Programmable Soft Materials Containing Ferromagnetic Domains and Methods of Making, US 2020/0223099
11. X. Zhao, X. Liu, S. Lin, G. A. Parada, **H. Yuk**, Fast-swelling, highly-swellaable, robust hydrogel balloons, US 2021/0038871
12. **H. Yuk**, X. Zhao, Systems, devices, and methods for 3D printing by harnessing deformation, instability, and fracture of viscoelastic inks, US 2020/0368962
13. G. A. Parada, **H. Yuk**, X. Zhao, Tough hydrogel coating and method of manufacture, US 2019/0125934
14. **H. Yuk**, X. Zhao, Hydrogel-elastomer hybrids, US 2019/0070826
15. **H. Yuk**, S. Lin, T. Zhang, X. Zhao, Stretchable, robust and biocompatible hydrogel electronics and devices, US 2017/0136180
16. **H. Yuk**, S. Lin, T. Zhang, G. Parada, X. Zhao, Multifunctional bonding of hydrogels, US 10954375
17. **H. Yuk**, S. Lin, X. Zhao, Extremely compliant yet tough hydrogel system as ultrasound transmission agents, US 9878506

MEDIA COVERAGES (SELECTED LIST)

1. My story on motivation, development, and translation of bioadhesive technologies is featured in [MIT News](#)
2. The paper “A multifunctional origami patch for minimally invasive tissue sealing (published in *Advanced Materials*)” was covered in [MIT News](#), [Mayo Clinic Discovery’s Edge](#)
3. I am selected as [2020 Collegiate Inventors Competition Graduate Winner](#)
4. The paper “Instant tough bioadhesive with triggerable benign detachment (published in *PNAS*)” was covered in [MIT News](#), [Tech Xplore](#), [Medgadget](#)
5. The paper “3D printing of conducting polymers (published in *Nature Communications*)” was covered in [MIT News](#), [The Medical News](#), [Tech Xplore](#)
6. The paper “Strong adhesion of wet conducting polymers on diverse substrates (published in *Science Advances*)” was covered in [MIT News](#), [Phys.org](#), [Science Daily](#)

7. The paper “Dry double-sided tape for adhesion of wet tissues and devices (published in *Nature*)” was covered in [MIT News](#), [Science Translational Medicine Editor's Choice](#), [BBC](#), [US News](#), [Smithsonian Magazine](#)
8. I am selected as [Forbes 30 Under 30 2019: Science](#)
9. The paper “Printing ferromagnetic domains for untethered fast-transforming soft materials (published in *Nature*)” was covered in [MIT News](#), [Forbes](#), [BBC](#), [National Geographic](#)
10. The paper “A new 3D printing strategy by harnessing deformation, instability, and fracture of viscoelastic inks (published in *Advanced Materials*)” was covered in [Advanced Science News](#)
11. The paper “3D printing of living responsive materials and devices (published in *Advanced Materials*)” was covered in [MIT News](#), [Advanced Science News](#)
12. The paper “Impermeable robust hydrogels via hybrid lamination (published in *Advanced Healthcare Materials*)” was covered in [MIT News](#)
13. The paper “Stretchable living materials and devices with hydrogel-elastomer hybrids hosting programmed cells (published in *PNAS*)” was covered in [MIT News](#), [Gizmodo](#)
14. The paper “Hydraulic hydrogel actuators and robots optically and sonically camouflaged in water (published in *Nature Communications*)” was covered in [MIT News](#), [Gizmodo](#), [The Verge](#), [Fox News](#), [Popular Science](#)
15. The paper “Highly stretchable, strain sensing hydrogel optical fibers (published in *Advanced Materials*)” was covered in [MIT News](#), [Fox News](#)
16. The paper “Skin-inspired hydrogel-elastomer hybrids with robust interfaces and functional microstructures (published in *Nature Communications*)” was covered in [MIT News](#), [Boston Magazine](#), [Bloomberg](#)
17. The paper “Stretchable hydrogel electronics and devices (published in *Advanced Materials*)” was covered in [MIT News](#), [NBC News](#), [Boston Herald](#), [MIT Technology Review](#), [Smithsonian Magazine](#)
18. The paper “Tough bonding of hydrogels to diverse non-porous surfaces (published in *Nature Materials*)” was covered in [MIT News](#), [Forbes](#), [Vice](#), [Materials Today](#)