Siniša Vukelić

Columbia University
Department of Mechanical Engineering
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Experience

Columbia University, New York, NY 7/2024 – present
Senior Lecturer in Discipline

Columbia University, New York, NY 9/2013 – 6/2024
Lecturer in Discipline

Bucknell University, Lewisburg, PA 08/2009 – 8/2013
Swanson Fellow Assistant Professor

Hospital for Special Surgery, New York, NY 06/2010 – 8/2013
Adjunct Assistant Scientist

Education

Columbia University, New York, NY 04/2009
Ph.D. Mechanical Engineering
Thesis: "Laser Induced Deformation and Structural Modification of Crystalline and Amorphous Materials"
Advisors: Profs. Y. Lawrence Yao and Jeffrey W. Kysar

Columbia University, New York, NY 05/2005
M.S. Mechanical Engineering

University of Belgrade, Belgrade, Serbia 06/2004
Dipl. Ing. Aeronautical Engineering
Thesis: "Parameter Computation of Dynamic Stability in Contemporary Aircrafts Using Differential Equations of Small Perturbations"
Advisor: Prof. Boško Rašuo

Research Interests

- Structural Modification of Biological Media Towards New Therapeutics and Diagnostics
  - Enhancement of Mechanical Properties of Articular Cartilage
  - Disease Diagnosis and Treatment Monitoring in of Articular Cartilage
  - Meniscus Repair
  - Development of Anti-inflammatory Treatment Modalities
  - Treatment of Ocular Media
- Spectroscopic Characterization of Biomaterials
- Optical Diagnostics and Treatment Monitoring
- Laser Induced Mechanical Deformation

Grant Awards

- Principal Investigator: NIH R21 R21EY039457-01 *Enhancement of corneal wound healing and inflammation management with laser-generated short bursts of reactive oxygen species*
  9/1/26 – 8/31/28 ($442,186) *Pending*
- Co-Principal Investigator (other co-PI: Gerard Ateshian): NIH R01 AR073289-01A1 *Laser Treatment Modality for Strengthening Osteoarthritic Cartilage*
  1/1/19 – 12/31/23 ($1,090,622)
- Principal Investigator: IP University Holdings *Femtosecond Laser Corneal Treatment to Validate Clinical Viability and Safety of the Technology (Extension)*, 1/1/19 – 12/31/19 ($322,693)
- Principal Investigator: IP University Holdings *Femtosecond Laser Corneal Treatment to Validate Clinical Viability and Safety of the Technology (Renewal)*, 1/1/18 – 12/31/18 ($809,693)

- Principal Investigator: IP University Holdings/Coulter Foundation/Columbia Technology Ventures (CTV) *Femtosecond Laser Corneal Treatment to Validate Clinical Viability and Safety of the Technology*, 1/1/17 – 12/31/17 ($391,000)
- Co- Principal Investigator (other co-PI: Michael Pitman): Columbia Biotechnology Accelerator: *Therapeutic OTC Inhalant Device to Alleviate Inflammation and Pain of the Upper Aerodigestive Tract* 9/1/18 – 8/31/19 ($100,000)
- Co- Principal Investigator (other co-PI: Alexander Kushnir): Coulter Foundation *inSensor: Novel device for reducing pulmonary complications in hospitalized patients by improving compliance with incentive spirometer use*, 7/1/17-6/31/18 ($40,000)
- Principal Investigator: Coulter Foundation/Columbia Technology Ventures (CTV) PG004249 - WHCF CU12-0369 *Laser-Assisted Noninvasive Permanent Vision Correction*, 11/1/15-12/31/17 ($65,000)
- Co- Principal Investigator (other co-PI: Alexander Kushnir): Coulter Foundation PG004249 *urOvol: Optimizing medical management through continuous and seamless urine output monitoring,* 7/1/16-12/31/17 ($50,000)
- Principal Investigator: Instrumentation Grant at Center for Functional Nanomaterials (CFN) of Brookhaven National Lab (BNL) *Development of Automated, High Throughput Diagnostics Tool for Prostate Cancer Diagnostics*
- Principal Investigator: Instrumentation Grant at Center for Functional Nanomaterials (CFN) of Brookhaven National Lab (BNL) *Femtosecond Laser Treatment of the Interior of Bulk Transparent Dielectrics*
- NSF DMR 0820404 Material Facilities Research Network Faculty Fellowship

Invited Talks/Papers

- Invited Talk: (2024) *Targeted Delivery of Femtosecond Laser Generated Reactive Oxygen Species as a Novel Therapeutic Platform,* SPIE Photonic West, January 27 – February 1, San Francisco, CA
- Invited Talk*:* (2020) *Femtosecond Oscillator-based Modification of Collagenous Tissues*, 20th Annual Wavefront and Presbyoptic Refractive Corrections Congress, February 21-22, Napa CA,
- Invited Talk*:* (2018) *A New Paradigm for Use of Ultrafast Lasers in Ophthalmology for Enhancement of Corneal Mechanical Properties and Permanent Correction of Refractive Errors*, International Society for Eye Research, XXII Biennial Meeting, September 9 – 13, Belfast, Northern Ireland, UK
- Invited Talk*:* (2018) *Correction of Hyperopia by Crosslinking Cornea with Femtosecond Laser*, 18th Anterior Segment Academy, April 27-28, Milan, Italy
- Invited Talk: (2013) *Structuring and Joining Transparent Materials with Ultra Short Pulse Lasers*, 32nd Int. Congress on Applications of Lasers and Electro-Optics (ICALEO '13), Miami FL
- Keynote Speaker: (2009) Int. Conference on Advances in Mechanical and Building Sciences, Vellore, India

Select Publications

1. Fan, J, Lee, W, Vukelic, S (2026) Corneal Collagen Crosslinking with Melanin-Enhanced Absorption of Femtosecond Laser Pulses, *in preparation*
2. Fan, J, Yang, L, Vukelic, S (2026) Effects of Combining External Mechanical Loading with Simultaneous Collagen Crosslinking onto Corneal Curvature and Stromal Ultrastructure, *in preparation*
3. Fan J, Vukelic S, (2026) Reactive oxygen species accelerated glycation for oxygen-independent corneal cross-linking, Front. Bioeng. Biotechnol. 14:1695384.
4. Fan, J, Fomovsky, M, Wang, C, Zyablitskaya, M, Sazeides, C, Bogunovic, D, Vukelic, S, (2025) Use of Femtosecond Laser Generated Reactive Oxygen Species to Manage Inflammation and Enhance Wound Healing After Ocular Trauma, Sci Rep 15, 20794
5. Sise, CV, Peterson, C, Ashford, AK, Yun, J, Zimmerman, BK, Vukelic, S, Hung, CT, Ateshian, GA (2025) A major functional role of synovial fluid is to reduce the rate of cartilage fatigue failure under cyclical compressive loading, Osteoarthritis and Cartilage, Vol 33(1), 94-100,

6. Sise, CV, Peterson, C, Yun, J, Vukelic, S, Hung, CT, Ateshian GA, (2024) Synovial Fluid Does Not Retard Fluid Exudation During Stress-Relaxation of Immature Bovine Cartilage, J Biomech. 2024 Nov;176:112340.

7. Fan, J and Vukelic, S (2023) Alteration of Epithelial-Stromal Interactions by NIR-femtosecond Laser Irradiation for Therapeutic Modulation of Wound Healing Process, *accepted to SPIE Mech. Photobiomod. Therapy.*

8. Fan, J, Wendt, JL, Yang, K, Mencattelli, M, Vukelic, S, Effects of Combining External Mechanical Load with UV-A Light/Riboflavin CXL onto Corneal Curvature. *Invest. Ophthalmol. Vis. Sci.* 2020;61(9):PB00105.

9. Kushnir, A, Eytan, P, Morris, N, Shahabuddin, Z, Hammond, J, **Vukelic, S**, Rabbani, L (2022) Improving Fluid Output Monitoring in the Intensive Care Unit, Journal of Intensive Care Medicine, J Intensive Care Med. *37(1) 114-119.*

10. Lei, S, Zhao, X, Yu, X, **Vukelic, S**, Jun, MGB, Joe, H-E, Yao, YL, Shin, YC, (2020) Ultrafast Laser Applications in Manufacturing Processes: A State-of-the-Art Review, J. Manuf. Sci. Eng, 142(3): 031005

11. Wang, C, Fomovsky, M, Miao, G, Zyablitskaya, M, **Vukelic, S** (2018) Femtosecond Laser Crosslinking of the Cornea for Noninvasive Vision Correction, Nature Photonics *12, 416-422 (cover article of July 2018 issue)*

12. Fomovsky, M, Wang, C, Roland-Hall, J, Paik, DC, Trokel, SL, **Vukelic, S**, (2017) A New Paradigm for Use of Ultrafast Lasers in Ophthalmology for Enhancement of Corneal Mechanical Properties and Permanent Correction of Refractive Errors, *Proc. of SPIE* 10066, Energy-based Treatment of Tissue and Assessment IX, 100660Y

13. Wang, C, Durney, KM, Fomovsky, G, Ateshian, GA, **Vukelic, S**, (2016) Quantitative Raman Characterization of Cross-linked Collagen Thin Films as a Model System for Diagnosing Early Osteoarthritis, *Proc. of SPIE Biomedical Vibrational Spectroscopy 9704: 970415*

14. Guo, Y, **Vukelić, S,** (2015) "Evolution of cavitation bubbles in corneal stroma subject to micro-Joule femtosecond laser Pulses," *Proc. of SPIE Optical Interactions with Tissue and Cells 9321: 932106.*

15. Guo, Y, Wang, C, Celi, NG, **Vukelić, S,** (2015) "Femtosecond laser collagen cross-linking without traditional photosensitizers," *Proc. of SPIE Optical Interactions with Tissue and Cells 9321: 932103.*

16. Wander, J, **Vukelić, S,** (2013) "Influence of tissue treatment onto the Raman spectra obtained from prostate histopathological slides for diagnostics purposes," Proc. of SPIE 8565, 85651F

17. Vukelić, S, Kongsuwan, P, Yao, YL, (2013) "Investigation of the morphology of the features generated via femtosecond lasers in the interior of a bovine cornea sections," Proceedings of the SPIE, Vol. 8579, 857904, 10 pp.

18. Vukelić, S, Noyan, IC, Kysar, JW, Yao, YL, (2011) "Characterization of Heterogeneous Response of Al Bicrystal Subject to Micro Scale Laser Shock Peening," Experimental Mechanics, 51(5), 793-796.

19. Vukelić, S, Kongsuwan, P, Yao, YL, (2010) "Ultra-Fast Laser Induced Structural Modification of Fused Silica. Part I: Feature Formation Mechanisms," Journal of Manufacturing Science and Engineering, Vol. 132, 061012-1.

20. Vukelić, S, Ryu, S, Yao, YL, (2010) "Ultrafast Laser Induced Structural Modification of Fused Silica. Part II: Spatially Resolved and Decomposed Raman Spectral Analysis" Journal of Manufacturing Science and Engineering, Vol. 132, 061013-1.

21. Kongsuwan, P, **Vukelić, S**, Yao, YL, (2010) "Characterization of Morphology and Mechanical Properties of Glass Interior Irradiated by Femtosecond Laser," Journal of Manufacturing Science and Engineering, 132(4), 041009

22. Wang, Y., Kysar, JW, **Vukelić, S**, and Yao, YL, (2009) "Spatially Resolved Characterization of Geometrically Necessary Dislocation Dependent Deformation in Microscale Laser Shock Peening," Journal of Manufacturing Science and Engineering, 131(4), 41014

23. Vukelić, S, Kysar, JW., and Yao, YL, (2008) "Grain Boundary Response of Aluminum Bicrystal Under Microscale Laser Shock Peening," International Journal of Solids and Structures, 46, 3323-3335.

24. Vukelić, S, Wang, Y, Kysar, JW, and Yao, YL, (2008) "Dynamic Material Response of Aluminum Single Crystal Under Micro Scale Laser Shock Peening," ASME Journal of Manufacturing Science and Engineering, 131, 031015-1 - 031015-10.

25. Vukelić, S, Wang, Y, Kysar, JW, and Yao, YL, (2008) "Comparative Study of Symmetric and Asymmetric Deformation of Al Single Crystal Under Micro Scale Laser Shock Peening," Journal of Mechanics of Materials and Structures, 4, 89-105.

26. Wang, Y, Fan, Y, Kysar, JW, **Vukelić, S**, and Yao, YL, (2008) "Micro-Scale Laser Peen Forming of Single Crystal," J. Appl. Physics, 103, 063525.

27. Wang, Y, Fan, Y, **Vukelić, S**, and Yao, YL, (2007) "Energy Level Effects on Deformation Mechanism in Micro-scale Laser Peen Forming," SME J. of Manufacturing Process, 9(1), 1-12.

28. Fan, Y, Wang, Y, **Vukelić, S**, and Yao, YL (2007) "Numerical Investigation of Opposing Dual Sided Microscale Laser Shock Peening" Transactions of the ASME J. of Manufacturing Science and Engineering 129, 256-264.

29. Fan, Y, Wang, Y, **Vukelić, S**, and Yao, YL, (2005) "Wave-solid Interactions in Shock Induced Deformation Processes," J. Appl. Physics, 98, 104904

Select Conference Publications

1. Fan, J and Vukelic, S, (2022) Oxygen-independent Corneal Crosslinking for Keratoconus Treatment and Non-invasive Vision Correction, *accepted to* CxL Experts Meeting, Zurich, Switzerland, December 8-11, 2022

2. Wang, C, Kroupa, KR, Ateshian, GA, Vukelic, S, (2022) Raman Spectroscopy of Proteoglycan-depleted Bovine Cartilage for Detection and Quantification of Pyridinium Crosslinks, , Orthopaedic Research Society (ORS) Annual Meeting 2022

3. Fan, J, Sise, CV, Kroupa, KR, Hung, CT, Ateshian, GA, Vukelic, S (2021) Crosslinking of Cartilage Collagen via Nonlinear Femtosecond Laser Activation of Riboflavin, Summer Biomechanics, Bioengineering and Biotransport Conference, June 14-18, Virtual

4. Sise, CV, Kroupa, KR, Fan, J, Hung, CT, Vukelic, S, Ateshian, GA (2021) Effect of Temperature on Equilibrium Compressive Modulus of Immature Bovine Articular Cartilage, Summer Biomechanics, Bioengineering and Biotransport Conference, June 14-18, Virtual

5. Kroupa, KR, Sise, CV, Hung, CT, Vukelic, S, Ateshian, GA (2021), Crosslinking of Collagen Across Cartilage Tears for Improved Interface Strength, Summer Biomechanics, Bioengineering and Biotransport Conference, June 14-18, Virtual

6. Wang, C, Fomovsky, M, Fan, J, Vukelic, S (2019) Novel, laser-assisted approach to noninvasive permanent correction of refractive errors, Association for Research in Vision & Ophthalmology Annual Meeting, Vancouver, British Columbia, Canada, April 28 – May 2, 2019

7. Durney-Antonelli, KM, Wang, C, Zimmerman, B, Sonar, S, Montegut, L, Bolene, MA, Guan, K, Hung, CT, Ateshian GA, **Vukelić, S**, (2018) Novel Laser Treatment Modality for Crosslinking and Strengthening Early-Stage Osteoarthritic Cartilage, *8th World Congress of Biomechanics, Dublin Ireland, July 8-12.*

8. Wang, C, Durney, KM, Fomovsky, M, Yu, J, Roland-Hall, J, Ateshian, GA, **Vukelić, S**, (2017) Femtosecond Laser Irradiation as Novel Paradigm for Treatment of Early Osteoarthritis, Orthopaedic Research Society (ORS) Annual Meeting 2017.

9. Fomovsky, M, Wang, C, Trokel, SL, **Vukelić, S**, (2017) Laser Induced Ionization Field Crosslinks Biological Media in Absence of Photosensitizers, International CxL Experts Meeting, Zurich, Switzerland, November 30 – December 2, 2017

10. Wang, C, Fomovsky, M, Fan, J, Diao, C, Zyablitskaya, M, **Vukelic, S** (2018) Laser Induced, Spatially Resolved, Alterations of Refractive Power in Rabbit Eyes *Ex Vivo*, *Proc. SPIE, Ophthalmic Technologies XVIII,* San Francisco, CA, January 28 – February 2, 2018.

11. Wang, C, Durney, KM. Kuo, JM, Fomovsky, G, Norton, JR Ateshian, GA, **Vukelić, S**, (2015) "Quantitative Analysis of Raman Spectra for Assessment of Crosslink Concentrations Toward Diagnosing Early Arthritis," 2015, SB3C Summer Biomechanics, Bioengineering and Biotransport Conference, Snowbird Resort, UT, June 17-20.

12. Durney KM, Nims RJ, Albro MB, Gu T, Karbowski L, Singh A, **Vukelic S**, Hung CT, Ateshian GA, (2015) Raman Spectrographic Characterization of Cartilage Matrix Swelling via Lysyl Oxidase Inhibition in Immature Explants and Tissue Constructs, Annual Meeting of the Orthopaedic Research Society, poster 0323, Las Vegas, NV, March 27-31

13. Fan, Y, Wang, Y, Vukelić, S, Yao, YL, "Wave-Solid Interactions in Shock Induced Deformation Processes," 24th International Congress on Applications of Lasers & Electro-Optics, ICALEO, October 31 - November 3, 2005, Miami, FL

14. Wang, Y, Fan, Y, Vukelić, S, Yao, YL., "Energy Level Effects on Deformation Mechanism in Micro- scale Laser Peen Forming," Transactions of 2006 North America Manufacturing Research Institute/SME, NAMRC 34, Vol. 34, 2006, May 23 - May 26, Milwaukee, WI
15. Vukelić, S, Wang, Y, Kysar, JW, Yao, YL, "Comparative Study of Symmetric and Asymmetric Deformation of Al Single Crystal Under Micro Scale Laser Shock Peening," 25th International Congress on Applications of Lasers & Electro-Optics, ICALEO, October 30 - November 2, 2006, Scottsdale, AZ
16. Vukelić, S, Kysar, JW, Yao, YL, "Grain Boundary Response of Aluminum Bicrystal Under Microscale Laser Shock Peening," ASME Internatonal Conference on Manufacturing Science & Engineering (MSEC), October 15 - October 18, 2007, Atlanta, GA
17. Wang, Y, Fan, Y, Kysar, JW, Vukelić, S, Yao, YL, "Micro-Scale Laser Peen Forming of Single Crystal," 26th International Congress on Applications of Lasers & Electro-Optics, ICALEO, October 29 - November 1, 2007, Orlando, FL
18. 11. Vukelić, S, Gao, B, Ryu, S, Yao, YL, "Structural Changes of Amorphous Fused Silica Under Femtosecond Laser Irradiation," International Conference on Manufacturing Science and Engineering (MSEC), October 7 – October 10, 2008, Evanston, IL
19. 12. Vukelić, S, Kysar, JW, Yao, YL, "Comparison of Anisotropic and Inertial Effects in Single Crystals Under Micro Scale Laser Shock Peening," Transactions of North America Manufacturing Research Institute/SME, NAMRC 37 Clemson University, May 19-22, 2009, Greenville, S.C.
20. 13. Kongsuwan, P, Wang, H, Vukelić, S, Yao, YL, "Characterization of Morphology and Mechanical Properties of Glass Irradiated by Femtosecond Laser,"Proc. 28th Int. Congress on Applications of Lasers and Electro-Optics (ICALEO '09), Orlando FL, Nov. 2009, pp 1214-1223

Book Chapter

- A.J. Birnbaum (equally contributed), **S. Vukelic** (equally contributed) and Y.L. Yao, "Laser Induced Plastic Deformation" in Advances in Laser Materials Processing Technology Woodhead Publishing, Cambridge, Great Britain and CRC Press, Boca Raton, USA 2010

Patents

- *Laser Induced Collagen Crosslinking in Tissue Patent* *#10,940,042*
- *Laser Induced Collagen Crosslinking in Tissue Patent* *#11,559,433*
- *Devices, Methods, and Systems for Detection of Collagen Tissue Features Patent* *#11,497,403*
- *Diagnosis and Treatment of Collagen-Containing Tissues Patent* *#11,666,481*
- *Treatment of Cornea Using Crosslinking and Mechanical Load* *Application #17/890,905*
- *Systems and Methods for Modulating Cytokine Activity* *Application #17/031,746*
- *Oxygen-Independent Corneal Cross-Linking For Keratoconus Treatment And Non-Invasive Vision Correction Application #63/378,725*
- *Oxygen-Independent Corneal Cross-Linking For Keratoconus Treatment And Non-Invasive Vision Correction Application #63/386,662*
- *Femtosecond Laser Crosslinking for Enhancement of Collagenous Tissues* *Application #63/497,948*
- *Laser-Induced Collagen Crosslinking in Tissue* *Application #18/096,307*
- *Methods, Computer-Readable Media, and Systems for Treating a Cornea* *Application #19744571.1*
- *Methods, Computer-Readable Media, and Systems for Treating a Cornea* *Application #16/936,768*
- *Collagen Tissue Modification* *Application #17/122,392*
- *Methods, Computer-Readable Media, and Systems for Treating a Cornea* *Application #17/298,196*

NSF Panelist and Reviewer of Technical Papers

NSF panel in Fall 2009, 2013; 2017 ASME Journal of Manufacturing Science and Engineering, SME Journal of Manufacturing Processes, LIA Journal of Laser Applications, Experimental Mechanics, Journal of Physics D – Applied Physics, International Congress of Lasers and Electro-Optics (ICALEO), North American Manufacturing Research Conference (NAMRC), ASME International Conference of Manufacturing Science and Engineering (MSEC), Biomedical Circuits and Systems Conference (BIOCAS)

Professional Affiliations

The International Society for Optics and Photonics (SPIE), American Society of Mechanical Engineers (ASME); Association for Research in Vision & Ophthalmology (ARVO); Materials Research Society (MRS)