HYOUNGSOO KIM

INVITED TALK 9

Stretchable Dielectric Barrier Discharge Plasma Source for Healthcare Applications

Jeongsu Pyeon[1], Seong-Cheol Huh[2], Sanghoo Park[2], and Wonho Choe[2], Hyoungsoo Kim[1]*

[1] Department of Mechanical Engineering, Korea Advanced Institute of Science and Technology, Daejeon Zip:34141, Republic of Korea
[2] Department of Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology Zip: 34141, Republic of Korea

***Corresponding author:** hshk@kaist.ac.kr

Abstract

Flexible dielectric barrier discharge (FXDBD) plasma has gained interest for its ability to enhance plasma uniformity on complex surfaces through direct contact. However, current FXDBD sources are hindered by their reliance on only bendable substrates and electrodes, restricting their versatility and application potential. Herein, we explore the potential utilization of liquid metal electrodes for a stretchable-flexible DBD (*sf*-DBD) plasma. To attain this, we employed liquid metal particle ink, which features attributes such as coffee-ring-less, crack-less, bilayer-free, and post-processing-free, achieved solely through simple evaporation, while maintaining high electrical conductivity. The resulting *sf*-DBD exhibits excellent stretchability on various dielectric substrates and sustained stretchable-flexible plasma performance over long-term periods without degradation or hysteresis, displaying a consistent linear power increase trend during biaxial deformation. Ultimately, we demonstrate a self-deformable freeform *sf*-DBD actuator tailored to the curved geometries of target objects. We believe that our *sf*-DBD source can deliver chemical gases from the plasma rapidly and with high uniformity across the surface of the target object, even with complex geometries, to ensure an effective chemical reaction for healthcare purposes. This work elucidates the physicochemical pathways, paving the way for advanced sf-DBD sources.

Keywords: Surface DBD plasma, Liquid metal electrodes, Stretchable and flexible electronics, Healthcare devices

CURRICULUM VITAE

Name:	Hyoungsoo Kim
Academic positions:	Associate Professor
Workplace:	KAIST
Address:	Daehakro 291, N7-5110, Daejeon 34141, Republic of Korea
Email:	hshk@kaist.ac.kr
Expertise:	Fluid mechanics, Soft matter, Flow visualization

Education History

[Doctorate]	2008-2013	Department of Mechanical Engineering, Delft University of Technology
[Master]	2006-2008	Department of Mechanical Engineering, KAIST
[Bachelor]	1999-2006	Department of Mechanical Engineering, Kumoh National Institute of Technology

Professional Background

2024-Present	Director of Active Plasma Control Research Laboratory
2021-Present	Associate Professor, Department of Mechanical Engineering, KAIST
2019-Present	Editorial Board Member, Experiments in Fluids
2022	Visiting Scholar, Department of Physics & Applied Physics, Harvard University (Prof. David Weitz)
2017-2021	Assistant Professor, Department of Mechanical Engineering, KAIST
2013-2016	Postdoctoral Research Associate, Department of Mechanical and Aerospace Engineering, Princeton University (Prof. Howard A. Stone)

Selected Awards and Honors

1. 2024 Kasan Research Award, The Korean Society of Mechanical Engineers
2. 2022 Technology Innovation Award, KAIST
3. 2021 Fusion Research Award, KAIST
4. 2021 Songam Future Scholar for Excellent research, KAIST
5. 2018 Young Engineering Award, The Korea Society of Visualization

Selected Publications

1. J. Pyeon, S. Park, J. Kim, J.-H. Kim, Y.-J. Yoon, D.-K. Yoon, **H. Kim**, "Plasmonic metasurfaces of cellulose nanocrystal matrices with quadrants of aligned gold nanorods for photothermal anti-icing," *Nat. Commun.* 14:8096 (2023)
2. B. T. Gidreka and **H. Kim**, "Effects of physical property changes of expelled respiratory liquid on atomization morphology," *J. Fluid Mech*. 960, A10. (2023)
3. J. Pyeon, K. M. Song, Y. Jung, and **H. Kim**, "Self-induced solutal Marangoni flows realize coffee-ring-less quantum dot microarrays with extensive geometric tunability and scalability," *Adv. Sci.* 2104519 (2022)
4. **H. Kim**, K. Muller, O. Shardt, S. Afkhami and H.A. Stone, "Solutal-Marangoni flows of miscible liquids drive transport without surface contamination," *Nat. Phys.* **13**, 1105–1110 (2017)
5. **H. Kim**, F. Boulogne, E. Um, I. Jacobi, E. Button, and H. A. Stone, "Controlled uniform coating induced by the interplay of Marangoni flows and surface-adsorbed macromolecules," *Phys. Rev. Lett.* **116**, 124501 (2016)