Advanced electrohydrodynamics pump model developed for ultra-compact gas lasers

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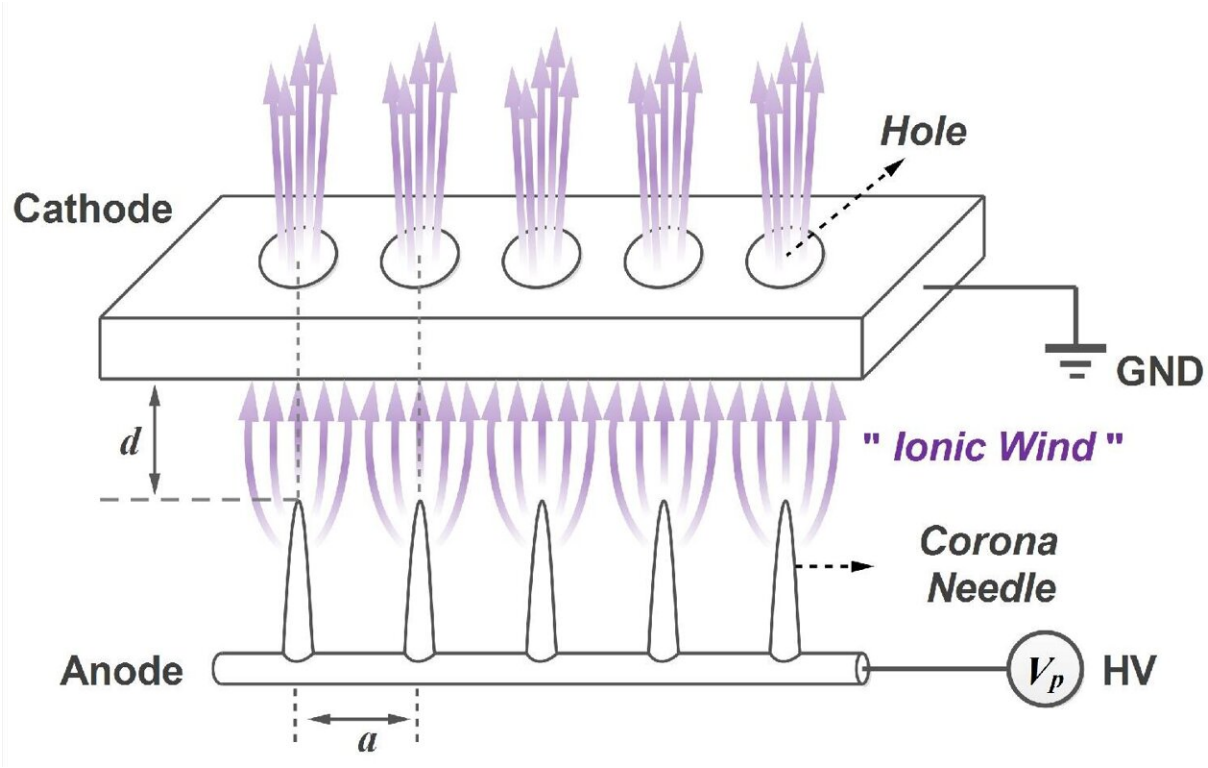

Schematic diagram of the EHD system structure of multi-needle. Credit: Liang Xu

A research group led by Prof. Liang Xu from the Anhui Institute of Optics and Fine Mechanics, Hefei Institutes of Physical Science of Chinese Academy of Sciences, propose a coupling analysis model

revealing the flow characteristics and control laws of a multi-needle Electrohydrodynamics (EHD) pump.

This model, designed for non-mechanical medium circulation in ultra-compact gas laser systems, addresses application challenges in these systems. The research results were published in *Physics of Fluids*, and selected by the journal as Editor's Pick.

The traditional gas laser adopts a mechanical circulation device to form high-speed medium circulation, which has the characteristics of large volume, strong vibration and serious noise.

EHD pumps generate "ionic wind" through corona discharge and have the advantages of lightweight, no vibration, no noise, etc., that can replace traditional mechanical circulation devices in miniaturized gas laser systems and expand the application of gas lasers.

In this study, researchers investigated the flow distribution and velocity characteristics of a multi-needle corona discharge EHD pump. They derived a simplified nonlinear steady-state EHD equation and designed a high-precision and fast numerical calculation algorithm for the flow velocity profile. The control characteristics of steady velocity with voltage and electrode spacing were given.

This study revealed, for the first time, the flow characteristics and the influence of parameters of the multi-needle corona discharge EHD pump. Furthermore, it provided guidance for the practical design of miniaturized EHD pumps and their application in gas lasers.

The designed electrohydrodynamic pumps can be used as the non-mechanical dielectric cycle driver of the ultra-compact gas laser system, supporting the normal glow discharge of the main electrode and expanding the applications of these systems in specialized environments

such as airborne, vehicular, and shipborne settings.

"Our finding provides theoretical support and analytical tools for further research and development of ultra-compact miniaturized gas laser systems," said Prof. Liang Xu.

More information: Jin-Liang Han et al, Analytical model and flow velocity control of electrohydrodynamics system with multi-needle corona discharge, *Physics of Fluids* (2024). DOI: 10.1063/5.0217043

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