# Influence of the Microplasma Actuator Electrode Configuration on the Induced EHD Flow

**Marius Blajan, Daisuke Nonaka, Jaroslav Kristof, and Kazuo Shimizu**

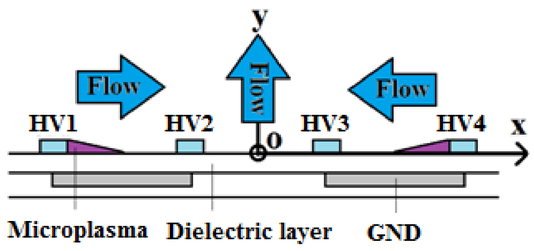
*Shizuoka University, Nakaku, Johoku, Hamamatsu, 432-8561, Japan*

Plasma actuator is a flow control device that has been investigated for flow separation control, drag reduction, and so on, due to its advantages such as simple construction, no moving parts, and quick response.

In this study, numerical simulations were carried out in order to obtain and insight of the phenomena especially near the electrode surface where experimental measurements are difficult. Our microplasma actuator with four independent channels can generate various directional types of flow by controlling which electrodes are energized. The influence of the number of electrodes on the induced flow was investigated.

## 1. Introduction

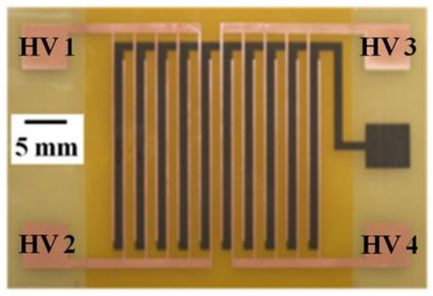
**Depending of which electrodes are energized, induced flow with different directions was generated and collided, thus resulting in directional flow [1]. Up to 50 ms leftward flow was obtained and after 50 ms the electrodes configuration was changed and upward flow was obtained.**



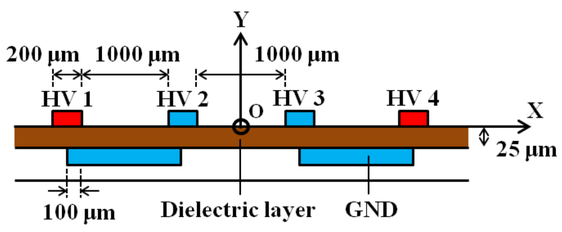

## 2. Microplasma Actuator

### Microplasma actuator

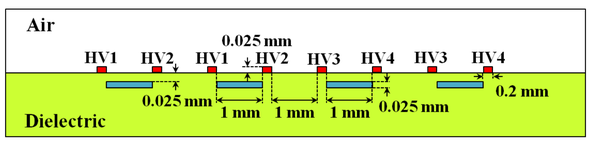
**Top view**




**Side view**



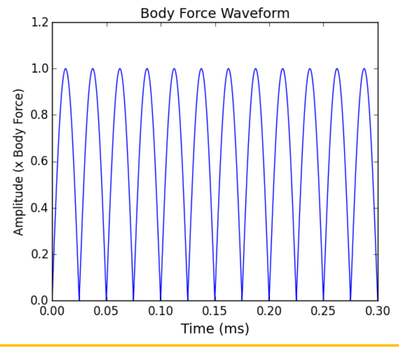

### Computational geometry




**By energizing electrodes HV2 and HV4 leftward flow was obtained and for electrodes HV1 and HV4 upward flow was obtained.**

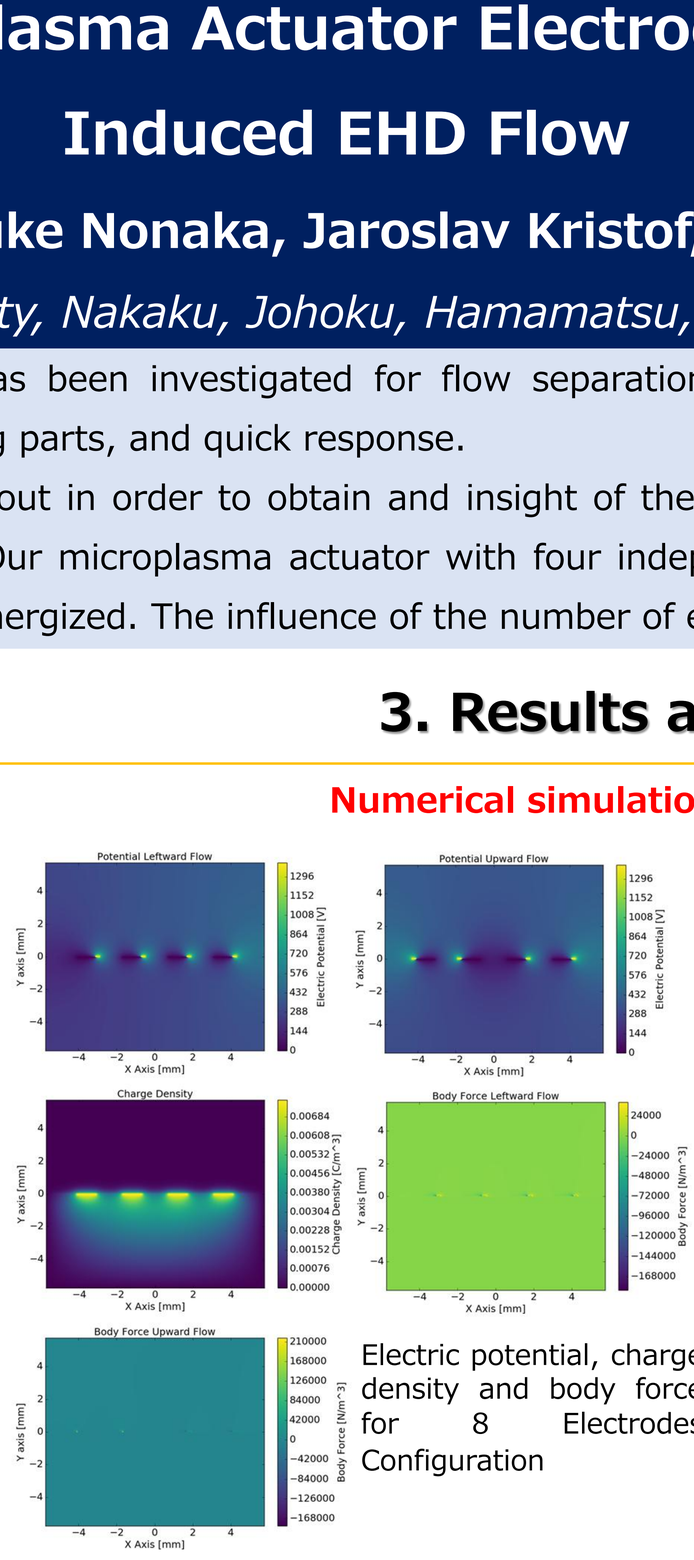
### Numerical Simulations

**The applied voltage was sinusoidal with amplitude 1.4 kV and frequency 20 kHz. A numerical simulation program was developed based on Suzen model coupled with Navier-Stokes equations.**

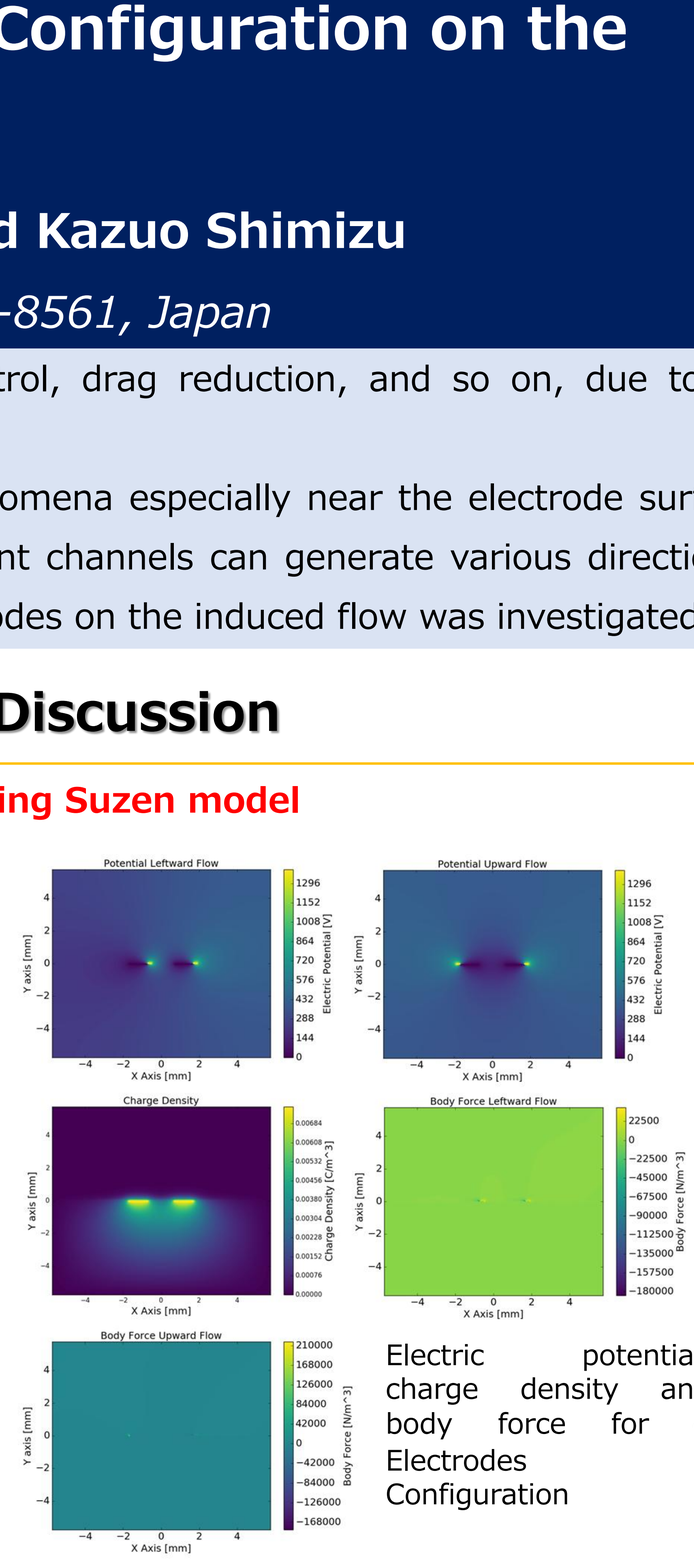



## 3. Results and Discussion

### Numerical simulations using Suzen model

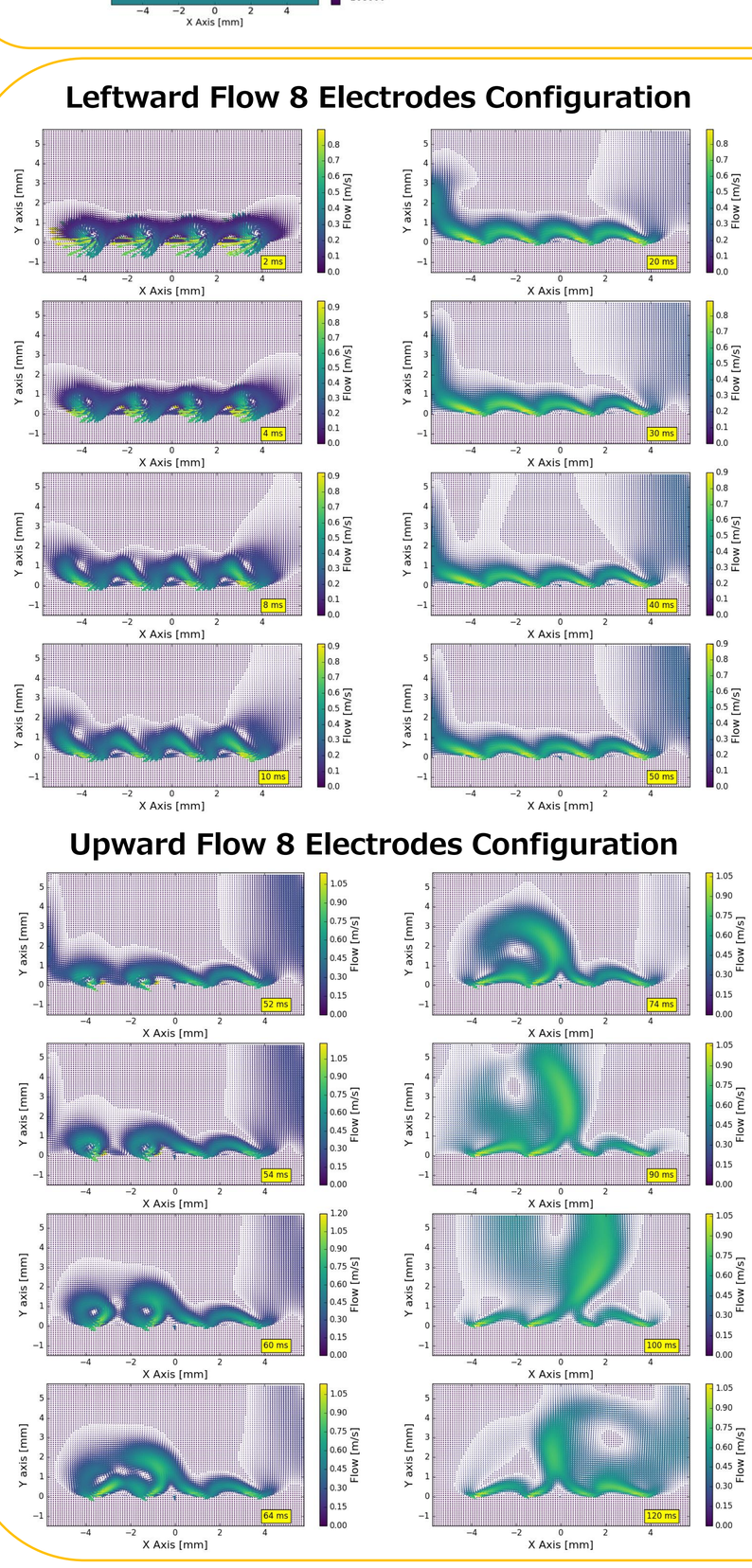



Electric potential, charge density and body force for 8 Electrodes Configuration

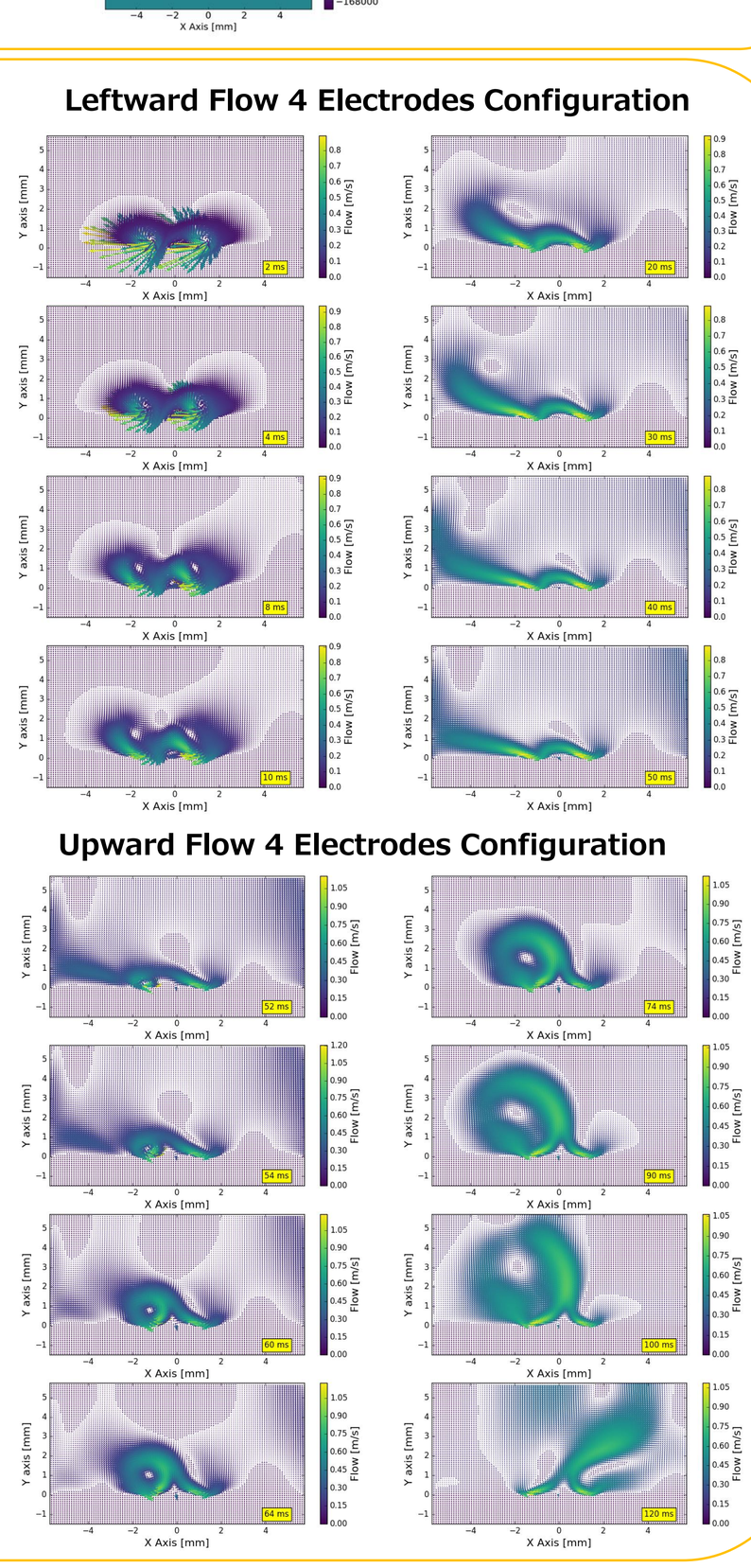



Electric potential, charge density and body force for 4 Electrodes Configuration

### Leftward Flow 8 Electrodes Configuration




### Leftward Flow 4 Electrodes Configuration




### Upward Flow 8 Electrodes Configuration




### Upward Flow 4 Electrodes Configuration




## 4. Conclusions

■ **HV2 and HV4 electrodes leftward flow maximum flow:**
**4 Electrodes : 0.89 m/s; 8 Electrodes : 0.9 m/s**

■ **HV1 and HV4 electrodes upward flow maximum Flow:**
**4 Electrodes : 1.07 m/s; 8 Electrodes : 1.08 m/s**

■ It was confirmed that vortices developed with the lapse of time.

■ Up to 50 ms, leftward flow was obtained and the maximum flow was faster in the case of 8 electrodes than the 4 electrodes.

■ After 50 ms the induced flow transitioned to upward flow. The transition from leftward flow to upward flow was faster in the case of 8 electrodes configuration.

[1] M. Blajan, Y. Mizuno, A. Ito, and K. Shimizu, “Microplasma Actuator for EHD Induced Flow,” IEEE Transaction on Industry Applications, Vol. 53, No. 3, May/June 2017, pp. 2409-2415.