Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Pattern formation of three-dimensional electroconvection on a charge selective surface[1] SOOHYEON KANG, RHOKYUN KWAK, Hanyang University, Korea — Electroconvection (EC) has been in the spotlight for enhancing ion flux in various electrochemical systems, but its dynamics is yet to be probed in three-dimensions. In this paper, we describe the first laboratory observation of 3-D EC on an exchange membrane and its pattern diversification. Combining experiment and scaling analysis, we successfully categorized three distinguished patterns of 3-D EC according to Reynolds number (Re), electric Rayleigh number ($\mathrm{Ra_E}$) and Schmidt number (Sc) as i) polygonal, ii) transverse, or iii) longitudinal rolls. If Re increases or $\mathrm{Ra_E}$ decreases, pure longitudinal vortices are presented. On the other hand, transverse rolls are formed between longitudinal rolls, and two rolls are transformed as polygonal rolls at higher $\mathrm{Ra_E}$ or lower Re. In this pattern selection scenario, Sc determines the critical electric Rayleigh number ($\mathrm{Ra_E^*}$) for the onset of each transverse or polygonal rolls, resulting $\mathrm{Ra_E^* \sim Re^2 Sc}$. We also verify that convective ion flux by EC (represented by an electric Nusselt number, $\mathrm{Nu_E}$) is fitted to a power law, $\mathrm{Nu_E \sim Ra_E^{0.48} Sc^{0.39}}$.

[1]This work was supported by the Climate Change Response Technology Development Project (NRF-2017M1A2A2047475) and the Basic Research Project (NRF-2019R1C1C1008262) from the National Research Foundation of Korea.

Soohyeon Kang
Hanyang University, Korea

Date submitted: 30 Jul 2019 Electronic form version 1.4