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Scaling law of velocity and conductivity in EK turbulence[1] WEI ZHAO, Department of Mechanical Engineering, University of South Carolina, FANG YANG, Carnegie Mellon University, GUIREN WANG, Department of Mechanical Engineering & Biomedical Engineering Program, University of South Carolina — In microfluidics, when electrokinetic (EK) flow is applied with sufficiently high electric Rayleigh number (Ra_e), turbulence can be achieved, and there can even be an universal equilibrium range of conductivity field. In this flow, a new scaling law region of velocity and conductivity structures where the energy cascade is dominated by electric body force (EBF) can be found. This is similar to the Bolgiano-Obukhov scaling law (BO59) in Rayleigh-Bénard (RB) convection. By both directly analyzing Navier-Stokes (N-S) equation and dimensional analysis, the scaling exponent of the second order moment of velocity structure function is 2/5, while that of conductivity structures is 4/5. Compared to the buoyancy in RB convection which decreases with decreasing length scale, EBF actually increases with decreasing spatial scales. This leads to two different microscales depending on the strength of EBF. The scaling law of velocity fluctuation is verified experimentally in a micro-EK turbulent flow. Although due to the restriction of geometry of our microchannel, the bandwidth of the EBF dominant subrange is narrow. By adjusting Ra_e and other parameters, a wider EBF dominant subrange is predicable.

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