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Nanofluidic Transistor Circuits[1] HSUEH-CHIA CHANG, LI-JING CHENG, YU YAN, ZDENEK SLOUKA, SATYAJYOTI SENAPATI, University of Notre Dame — Non-equilibrium ion/fluid transport physics across on-chip membranes/nanopores is used to construct rectifying, hysteretic, oscillatory, excitatory and inhibitory nanofluidic elements. Analogs to linear resistors, capacitors, inductors and constant-phase elements were reported earlier (Chang and Yossifon, BMF 2009). Nonlinear rectifier is designed by introducing intramembrane conductivity gradient and by asymmetric external depletion with a reverse rectification (Yossifon and Chang, PRL, PRE, Europhys Lett 2009-2011). Gating phenomenon is introduced by functionalizing polyelectrolytes whose conformation is field/pH sensitive (Wang, Chang and Zhu, Macromolecules 2010). Surface ion depletion can drive Rubinstein's microvortex instability (Chang, Yossifon and Demekhin, Annual Rev of Fluid Mech, 2012) or Onsager-Wien's water dissociation phenomenon, leading to two distinct overlimiting I-V features. Bipolar membranes exhibit an S-hysteresis due to water dissociation (Cheng and Chang, BMF 2011). Coupling the hysteretic diode with some linear elements result in autonomous ion current oscillations, which undergo classical transitions to chaos. Our integrated nanofluidic circuits are used for molecular sensing, protein separation/concentration, electrospray etc.

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