

# Modeling of Charge Transport in Ion Bipolar Junction Transistors

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## Abstract

Modeling of an ion bipolar junction transistor (IBJT) is performed using the COMSOL Multiphysics® software. Our model describes the IBJT which was developed and characterized [1]. The IBJT under consideration consists of a collector, an emitter, a base and a neutral junction. The emitter and the collector are anion-selective layers while the base is a cation-selective layer. The physical model is based on Poisson and Nernst-Planck (PNP) equations. Parameters used in the model are estimated from material properties and no fitting of the parameters to experimental data is performed. A two dimensional (2D) model of the device is employed which successfully reproduces the main characteristics of the measured data, such as the transfer and output characteristics. We study the concentration and potential profiles for the active, saturation and cutoff operation modes of the IBJT. A high ion concentration within the junction provides a high collector current and the collector current drops to zero when the junction is depleted of ions. Finally, we study the effect of the base and collector voltages on the evolution of the space charge region at the junction/collector interface. The prospects and limitations for future improvements of IBJTs are discussed.

## Reference

1. Klas Tybrandt et. al., Toward Complementary Ionic Circuits: The npn Ion Bipolar Junction Transistor, *J. Am. Chem. Soc.* 133, 10141-10145 (2011)