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Thermionic and Field emission model of 2D materials cathode

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Electron emission from a material through an interface to vacuum or another material is a fundamental process in cathode, diode, ionization, electric contact and many other areas. Depending on the energy used, it can be broadly characterized into 3 different processes known as thermionic emission TE (by thermal energy), field emission FE (by quantum tunneling) and photoemission PE (by absorption of photons or optical tunneling). The basic models for these processes (TE, PE, PE) have been formulated many decades ago, known as the Richardson law, Child-Langmuir (CL) law, Fowler-Nordheim (FN) law, and the Keldysh model. With the development of two-dimensional (2D) atomic scale materials in the 2000's (like graphene), the above-mentioned classical laws may require revisions to account for new material properties. In this talk, we will present the new emission models (thermionic and field emission) for 2D materials like graphene, and to show that the traditional models are no longer valid. The new models include the effects of linear energy dispersion over a wide energy range, and the momentum non-conservation. These new models will exhibit smooth transition to the traditional models and also new scaling laws agreeable with recent experiments. The applications of the models are not limited to cathodes but to other applications such as charge injection across electrical contact composed of 2D materials and bulk materials widely used in electronics and photonics.

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