Optimal Doping Profiles via Geometric Programming

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We first consider the problem of determining the doping profile that minimizes base transit time in a (homojunction) bipolar junction transistor. We show that this problem can be formulated as a geometric program, a special type of optimization problem that can be transformed to a convex optimization problem, and therefore solved (globally) very efficiently. We then consider several extensions to the basic problem, such as accounting for velocity saturation, and adding constraints on doping gradient, current gain, base resistance, and breakdown voltage. We show that a similar approach can be used to maximize the cutoff frequency, taking into account junction capacitances and forward transit time. Finally, we show that the method extends to the case of heterojunction bipolar junction transistors, in which the doping profile, as well as the profile of the secondary semiconductor, are to be jointly optimized.