The 1/*f* noise: Burial is abolished (or postponed)

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Seven years ago, a presentation proposing the end of 1/*f* noise was presented at the "Future Trends in Microelectronics: The Nano Millennium" workshop on Ile de Bendor (2001). This presentation was based on numerous papers where the end of 1/*f* noise was predicted in devices "of next generation". It was posited that 1/*f* noise would vanish as the size of "future" semiconductor devices decreased further.

It looked like these macabre predictions were based on a very firm foundation. Indeed, it is widely believed that 1/*f* noise in semiconductors (and metals) appears as a superposition of "elementary random processes", *i.e.* processes that are characterized by a single time constant τ_i (Lorentzians) with very wide distribution of characteristic times τ_i. Even several "luckily positioned" Lorentzians can create an illusion of 1/*f* noise (at some temperature). However, if there are only one, two or three defects in the sample, one can observe just separate Lorentzians:

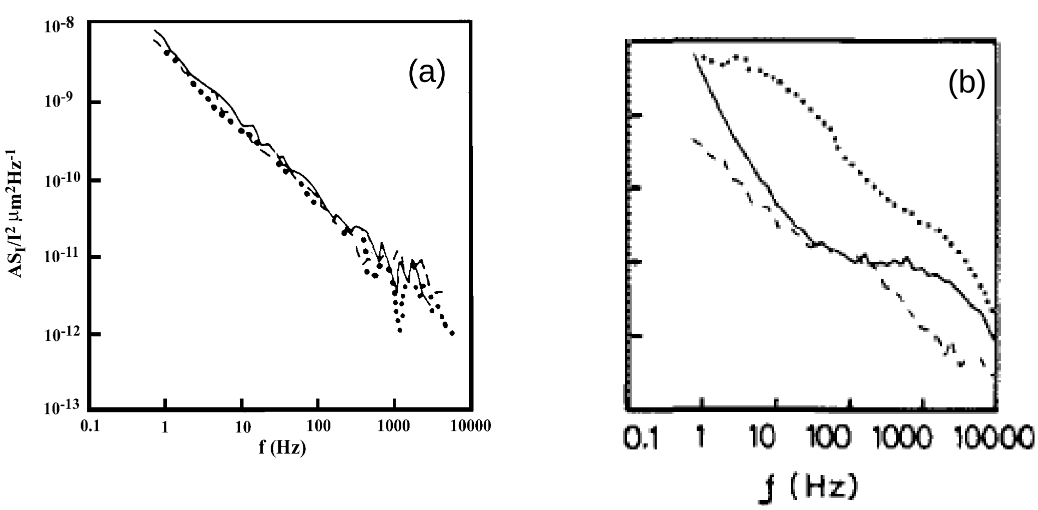

FIG. 1. (a) Noise power spectra of *n*-channel MOSFETs for three devices with active areas of 350 μm^2 (~10^7 carriers) and (b) for three devices with active areas of 0.4 μm^2 (~10^3 carriers) [from Uren *et al.*, *Appl. Phys. Lett.* **47**, 1195 (1985)].

The "future" is now the present and, surprisingly, the prediction failed. We report the data on the 1/*f* noise in most modern semiconductor devices, including InAlAs/InGaAs MODFETs with gate length *L* = 60 nm; Si MOSFETs with gate length *L* = 30 nm; GaN nanowire transistors of 50-250 nm diameter; single-wall carbon nanotube devices (FETs); and bilayer graphene transistors. In all of these devices, the low frequency noise shows clear 1/*f* behavior (over which some Lorentzian G–R components may be superimposed).

We will discuss the reasons why this convincing, well founded, and solid prediction has failed.