The end of the 1/f noise

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The 1/f noise has been observed in hundreds of systems: physical, chemical, biological, and even in various human activities. For majority of these systems, we know little about the origins of the 1/f noise. However, in those few cases when the nature of the 1/f noise is clear, this noise is a superposition of "elementary random processes", i.e. processes which are characterized by a single time constant τ ("Lorentzians").

For semiconductors and semiconductor devices such "elementary processes" are well known (at last, in principle). These include: the capture of carriers from the active region of the device by surface traps (McWorter model and its modifications), the capture of the carriers by "volume" traps (Dyakonova-Levinshtein model), and mobility fluctuations due to carrier scattering from defects with lower symmetry than symmetry of the crystal (Kogan-Nagaev model, TLS models and their modifications).

As a rule, even 4-5 "happily" positioned Lorentzians can create an illusion of the 1/f like noise, especially in a narrow temperature interval. However, if there are only one or two elementary fluctuators in the active region of the device, the 1/f noise disappears. In that case, noise manifests itself like a random telegraph signal (RTS) and the frequency dependence of the noise spectral density exhibits well-resolved Lorentzians.

Break-up of the 1/f noise is a signal that the size of the device is too small to provide a homogeneous device-to-device, batch-to batch and wafer-to-wafer control. These limits are supposed to be fundamental. Even if the future devices use metal active regions instead of semiconductor ones, they still have to meet exactly the same problems either from single scattering centers or from trapping–detrapping processes at metal-insulator boundaries.