Terahertz Plasmonic Devices

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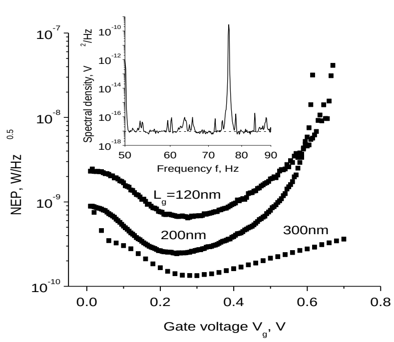
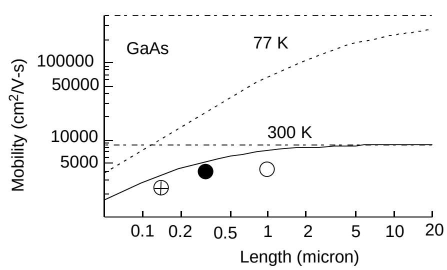
The field effect transistor feature sizes have shrunk to the point, where ballistic (collisionless) mode of electron transport is becoming dominant. In the ballistic regime, the device physics is completely different. For example, the effective electron mobility becomes proportional to the device feature size. At THz and sub-THz frequencies, the ballistic transport affects devices even with relatively large (submicron scale) feature sizes. THz radiation excites the waves of the electron density (i.e. plasma waves) in transistor channels. These waves have characteristic frequencies in the THz range even for devices with feature sizes exceeding a few hundred nanometers. Rectification of plasma waves can be used for detecting THz radiation and for imaging and in-situ testing of transistor structures. Since propagation of plasma waves is strongly affected by the field distribution in the device channel, plasmonic devices exposed to THz radiation could resolve nanometer feature sizes. In ballistic devices, plasma waves become unstable and cause THz emission. Plasma wave electronics detectors and sources are tunable by applied bias voltage and can be modulated at frequencies up to hundreds of gigahertz. Using synchronized THz transistor arrays instead of single devices is predicted to improve performance of plasmonic THz electronic detectors and sources by several orders of magnitude.



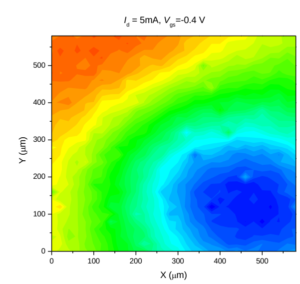
Sub THz detection by Si CMOS

From El Fatimy, N. Dyakonova, F. Teppe, W. Knap, D. B. Veksler, S. Rumyantsev, M. S. Shur, N. Pala, R. Gaska, Q. Fareed, X. Hu, D. Seliuta, G. Valusis, C. Gaquiere, D. Theron, and A. Cappy, Elec. Lett. (2006).



Ballistic Mobility

From M. S. Shur, IEEE EDL, Vol. 23, No 9, pp. 511 -513, September (2002)



THz Image of a FET

From Veksler, D.B. Muraviev, A.V. Elkhatib, T.A. Salama, K.N. Shur, M.S. Plasma wave FET for sub-wavelength THz imaging, International Semiconductor Device Research Symposium December 12-14, 2007 College Park, Maryland, USA