THz Transistors, sub-mm-wave ICs, mm-wave Systems

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Despite considerable challenges with materials properties and fabrication processes, transistor dimensions continue to shrink and transistor bandwidths continue to increase. 28-32 nm Si VLSI processes will be introduced into production this year; the transistors have sufficient gain for amplifiers to ~250 GHz. InP heterojunction bipolar transistor (HBT) processes at 250 nm feature size attain 800-900 GHz cutoff frequencies and have permitted construction of 340 GHz amplifiers. InP HBTs at the 128 nm and 64 nm scaling generations are in development and appear to be feasible; these should provide ~1-2 THz power-gain cutoff frequencies and enable radio links to 600-800 GHz. InP field-effect transistors (HEMTs) have demonstrated ~1 THz power-gain cutoff frequencies and 340 GHz amplifiers. Potential limits to the further improvements of such HEMTs include scaling of the gate dielectric capacitance density and the source/drain access resistivity; efforts in my laboratory and elsewhere to develop InP-based MOSFETs for VLSI will also facilitate the further scaling of InP FETs for THz operation. For high-frequency radios and RADARs, high atmospheric loss and short wavelengths together make the received signal very weak. Electronically steered high-directivity antennas, hence massive monolithic phased arrays, will be necessary for long link range.