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Graphene electronics: joule heat and charge density in active devices MARCUS FREITAG, MATHIAS STEINER, YVES MARTIN, VASILI PEREBEINOS, ZHIHONG CHEN, JAMES C. TSANG, PHAEDON AVOURIS, IBM TJ Watson Research Center — We use Raman scattering microscopy to measure the shifts of the 2D and G-bands resulting from the electronic power dissipation in the graphene sheet. Extracted images of the temperature distribution show peak temperatures of up to 1000K in the middle of the graphene device. The metallic contacts act as the dominant heat sinks, because the thermal conductivity of graphene is far greater than the gate-oxide thermal conductivity. We model thermal transport and obtain excellent agreement in peak temperature and functional form. Velocity saturation due to phonons with 50meV energy is observed, suggesting that substrate polar phonons limit the high-bias conduction in graphene. Trapped charges are also detected and we find that application of a high current is associated with drain-induced barrier lowering in back-gated graphene devices.

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