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Transport Properties of Gate Tunable Graphene-Based Tunnel Diodes DAMON FARMER, VASILI PEREBEINOS, PHAEDON AVOURIS, IBM T.J. Watson Research Center — Due to its linear dispersion relation and unique physical properties, graphene has become a material of intense experimental and theoretical investigation. There has been rapid progress in the fabrication and understanding of graphene devices, particularly those based on the field effect transistor (FET) configuration. These three-terminal switches rely on a gate field to control electronic transport (diffusive or quasi-ballistic) in the graphene channel, where the field is perpendicular to the current flow. Here, a different type of three-terminal graphene device is demonstrated, one based on quantum tunneling. These devices build upon the convention two-terminal metal-insulator-metal (MIM) tunnel diode configuration by replacing one of the metal electrodes with graphene. Incorporation of a third (gate) electrode allows for modulation of the accessible density of states in the graphene electrode, thereby tuning the threshold voltage for tunneling in the diode. This tunable diode concept, where the gate field is parallel to the tunneling direction, is novel for a purely solid-state system. The device characteristics owing to the unique properties of graphene will be discussed, as will the underlying physics of device operation.

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