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This paper reviews the crystal growth, basic properties, and principle of operation of III-nitride based terahertz devices. We provide a brief history and current status of crystal growth of polar and non-polar GaN-based heterostructures and its properties. The role of spontaneous and piezoelectric polarization in polar III-nitride structures and its impact on performance of terahertz devices is discussed in detail. We show that GaN-based semiconductor compounds are promising materials for fabrication terahertz sources operating up to room temperature due to their unique properties such as large bandgap and conduction band offset (CBO) energy, high LO-phonon energy, and high resistant to the high breakdown electric field. Moreover, it was established that the GaN-based terahertz sources can cover the spectral region of 5–12 THz, which is very important for THz imaging and detection of explosive materials, and which could be not covered by conventional GaAs-based terahertz devices. In terms of the reported significant progress in growth of non-polar m-plane GaN-based heterostructures and devices with low density defects, it is open a wide perspective towards design and fabrication of non-polar m-plane GaN-based high power terahertz sources with capabilities of operation at room temperature.