Advances in nonintrusive laser-based diagnostic tools have had tremendous impact on our understanding of the fundamental physical and chemical characteristics of reacting flows such as flames and plasmas. However, application of such diagnostic methods in practical combustion devices, for example gas turbine combustors, are rather infrequent because of limited optical access as well as performance limitations of traditional laser systems. In recent years, our research group has made significant advances in developing optical-fiber-based linear and nonlinear optical diagnostic techniques such as particle-image velocimetry (PIV), laser-induced fluorescence (LIF), and coherent anti-Stokes Raman scattering (CARS). We exploit the fiber-coupled point and planar imaging of temperature and key reaction species using laser sources in the repetition rate range 10–10,000 Hz. The effects of delivering intense visible and ultraviolet laser beams through long optical fibers are investigated, and the system improvements for all-fiber-coupled CARS and planar LIF (PLIF) imaging systems are discussed. Furthermore, our research efforts extend to developing pulse-burst laser sources, which have the potential of extending data-acquisition bandwidths to the megahertz (MHz) regime for highly dynamic flow systems. Development of such fiber-based imaging systems and next-generation pulse-burst laser sources constitutes a major step in transitioning laser diagnostic tools from research laboratories to reacting flow facilities of practical interest.