Over the past decade, one of the major focal points for photonics has been on developing a new class of “plasmonic” structures and “metamaterials” as potential building blocks for advanced optical technologies, including data processing and storage; a new generation of cheap, enhanced-sensitivity sensors; nanoscale-resolution imaging techniques; new concepts for energy conversion as well as novel types of light sources. Designing plasmonic metamaterials with versatile properties that can be tailored to fit almost any practical need promises a range of potential breakthroughs. However, to enable these new technologies based on plasmonics, grand limitations associated with the use of metals as constituent materials must be overcome. Metals (such as silver and gold) commonly used in plasmonic metamaterials are soft materials with relatively low melting point. The fabrication and integration of metal nanostructures with existing semiconductor technology is challenging, and the materials need to be more precisely tuned so that they possess the proper optical properties to enable the required functionality. Emerging plasmonic materials such as transparent conducting oxides and transition metal nitrides can form the basis for practical, low-loss, CMOS-compatible and durable devices that could enable full-scale development of the plasmonic technology. New refractory materials can meet the challenges real-life applications face, particularly those characterized by high operation temperature, high pressure and harsh environment.