As complementary metal-oxide semiconductor (CMOS) devices shrink to smaller size, the problems related to circuit performance such as critical path signal delay are becoming a pressing issue. These delays are a result of resistance and capacitance product (RC time constant) of the interconnect circuit. A novel material with reduced dielectric constants may compromise both the thermal and mechanical properties that can lead to die cracking during package and other reliability issues. Boron carbon nitride (BCN) compounds have been expected to combine the excellent properties of boron carbide (B₄C), boron nitride (BN) and carbon nitride (C₃N₄), with their properties adjustable, depending on composition and structure. BCN thin film is a good candidate for being hard, dense, pore-free, low-k dielectric with values in the range of 1.9 to 2.1. Excellent mechanical properties such as adhesion, high hardness and good wear resistance have been reported in the case of sputtered BCN thin films. Problems posed by high hardness materials such as diamonds in high cutting applications and the comparatively lower hardness of c-BN gave rise to the idea of a mixed phase that can overcome these problems with a minimum compromise in its properties. A hybrid between semi-metallic graphite and insulating h-BN may show adjusted semiconductor properties. BCN exhibits the potential to control optical bandgap (band gap engineering) by atomic composition, hence making it a good candidate for electronic and photonic devices. Due to tremendous bandgap engineering capability and refractive index variability in BCN thin film, it is feasible to develop filters and mirrors for use in ultra violet (UV) wavelength region. It is of prime importance to understand process integration challenges like deposition rates, curing, and etching, cleaning and polishing during characterization of low-k films. The sputtering technique provides unique advantages over other techniques such as freedom to choose the substrate material and a uniform deposition over relatively large area. BCN films are prepared by dual target reactive magnetron sputtering from a B₄C and BN targets using DC and RF powers respectively. In this work, an investigation of mechanical, optical, chemical, surface and device characterizations is undertaken. These holistic and thorough studies, will provide the insight into the capability of BCN being a hard, chemically inert, low-k, wideband gap material, as a potential leader in semiconductor and optics industry.