The research work for this thesis is built on design, development and integration of an in situ compression stage with micro-Raman spectrometer for structural characterization of ceramics and ceramic composites under uniaxial compression. An in situ compression stage has been designed, machined, and assembled using aluminum stainless steel alloys with a required and well-defined properties that allow the stage to be coupled with a Renishaw Raman spectrometer via Leica optical microscope. The in situ compression stage uses a stepper motor and two load screws that allow to apply high compressive stress of loads up to 14137 N resulting in stresses of up to 1 GPa depending on ceramic sample geometry. The system will be used in the future to study the structural changes in ceramics and ceramic composites, as well as to study thermal residual stress redistribution under applied compressive loads. A broad variety of Raman active ceramics, 3mol%Y2O3-ZrO2, LaCoO3, B4C, SiC, Si3N4, are potential candidates for such important fundamental studies enabled by the availability of the developed in situ compression stage. The in situ compression stage was tested once attached to the Renishaw Raman spectrometer using LaCoO3 ceramic samples. The Raman shift of certain peaks in LaCoO3 was detected indicative of the effect of the applied compressive stress on the ceramics understudy.