In this thesis, we studied phase transformations, microstructure, and mechanical properties of two newly designed alloys, Zr-4Sn-1Cr and Zr-4Nb-2Al (in wt%). Phase transformations were investigated, employing differential scanning calorimetry (DSC) and electric resistance measurements. The microstructure and phase composition were investigated using scanning electron microscopy (SEM) and X-ray diffraction analysis (XRD) in the cast+homogenized state and after various heat treatments. We studied the evolution of Zr_2Cr particles in the alloy Zr-4Sn-1Cr and observed the precipitation of intermetallic Zr_2Al and Zr_3Al phases in the alloy Zr-4Nb-2Al. We performed hot swaging of the studied alloys and investigated their mechanical properties using microhardness and tensile measurements. Both swaged alloys achieved higher ultimate tensile strength than commercially used Zircaloy-2 and Zircaloy-4.