I will first mention briefly recent progresses made by us towards a better understanding of the structure and the synthesis mechanism of superheavy nuclei. Then I will focus on the multi-dimensional potential energy surfaces of heavy and superheavy nuclei from covariant density functional theories (CDFT). With newly developed multi-dimensional constraint CDFTs, we are able to explore the importance of various shape degrees of freedom simultaneously along the fission path. For example, we found that aside from the octupole deformation, the triaxiality also plays an important role upon the second fission barriers: Both the outer and the inner barriers are lowered by the triaxial deformation compared with axially symmetric results. With many important shape degrees of freedom included in these CDFTs, one may predict more accurately the ground state and saddle point properties for superheavy nuclei.