Titanium dioxide (TiO₂) materials have been intensively studied in the past years because of many varied applications. This mini review article focuses on TiO₂ micro and nano architectures with the prevalent crystal structures (anatase, rutile, brookite, and TiO₂(B)), and summarizes the major advances in the surface and interface engineering and applications in environmental and electrochemical applications. We analyze the advantages of surface/interface engineered TiO₂ micro and nano structures, and present the principles and growth mechanisms of TiO₂ nanostructures via different strategies, with an emphasis on rational control of the surface and interface structures. We further discuss the applications of TiO₂ micro and nano architectures in photocatalysis, lithium/sodium ion batteries, and Li-S batteries. Throughout the discussion, the relationship between the device performance and the surface/interface structures of TiO₂ micro and nano structures will be highlighted. Then, we discuss the phase transitions of TiO₂ nanostructures and possible strategies of improving the phase stability. The review concludes with a perspective on the current challenges and future research directions.