Thermal plasma processing of Zinc (Zn) has been investigated for the surface morphological, structural, mechanical, and wettability modifications. For this purpose, the Ar thermal plasma irradiation has been performed with different exposure durations ranging from 5 minutes to 25 minutes in scanning mode at a constant Argon flow rate of 10 L/ min and applied voltage of 11 kV. Optical profilometry analysis revealed the increasing and decreasing trends in evaluated diameter and depth of the plasma sputtered region respectively with increasing treatment time. It also revealed the evolution of plasma irradiation from localized impacts to large scale surface structuring which is attributed to accumulated thermal effects. Scanning electron microscope analysis revealed the formation of flakes, blister, pores, eroded cavities, ridges, and loop like structures at different exposure time. The growth of various structures has been attributed to the gaseous diffusion, formation of bubbles, collisional / thermal sputtering and hydrodynamic instabilities. X-ray Diffraction (XRD) patterns of treated Zn targets exhibit significant variation in peak intensities, preferred orientation and 2θ position along with the formation of ZnO phase at higher treatment time which is explainable on the basis of plasma irradiation induced restructuring of Zn metal surface and its interaction with ambient oxygen. Variations in measured parameters of mean crystallite dimensions, dislocation line density, and stress/strain levels are also observed. Surface hardening measured by employing Vickers hardness tester showed an increasing trend with the increase of treatment time and is inversely proportional to the crystallite size in accordance with the Hall-patch relationship. The wettability is explored by measuring the water contact angle which showed an increasing and then decreasing trend with the increase of exposure time.