

Enhanced surface mechanical properties of structural steels by a surface nano-crystallization based duplex treatment processing

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Summary

Structural steels are widely used in engineering fields. Generally, they have the advantage of lower prices due to less precious alloy elements contained; however, their properties, especially the surface properties are inferior to high alloy steels. Surface engineering are of importance in improving surface properties of steels, and even a 'new' surface layer with high performances can be produced by surface technologies on low cost structural steels with ordinary properties.

The researches of last decade have shown that surface nanocrystallization (SNC) can markedly improve surface mechanical properties of metallic materials and accelerate thermal diffusion of N, Cr, etc atoms. In this work we try to combine SNC with hard coating technology into a new duplex treatment processing to enhance surface mechanical properties of structural steels. AISI 304 stainless steel was firstly studied. The steel was subjected to surface mechanical attrition treatment to form a nanocrystalline surface layer, and diamond-like carbon (DLC) film was deposited on SNCed and coarse grained 304 steel substrates by a closed-field unbalanced magnetron sputtering ion-plating system. The results by microhardness test, adhesion tests of indentation and scratch methods, wear and cyclic impact tests show that the hardness and load-bearing capability of the film/substrate system are obviously increased by SNC; film adhesion, wear resistance and cyclic impact resistance are also improved by SNC. The enhanced surface mechanical properties of 304 stainless steel by the hybrid treatment processing are related to the hard composite surface layer with good integrity. The advantages of this hybrid treatment over the single treatments or the traditional hybrid treatment consisting of nitriding and hard coating are discussed. The work on other structural steels e.g. low or medium carbon steels is now under way. The SNC based hybrid treatment will find potential applications in machine parts or other engineering fields.

Keywords: surface nanocrystallization; stainless steel; surface engineering; hard coating

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