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Effect of Methane Addition and Process Temperature on the Hardened Case Properties by Plasma Nitrocarburizing on DIN 100Cr6 Steel

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Plasma nitrocarburizing is a thermochemical process that employs the pulsed DC luminescent discharge technology to introduce both nitrogen and carbon into the surfaces of metals and their alloys. The case formed by the treatment typically consists of two different layers: an thin outer layer, named compound layer, which presents excellent wear and tribological performances, and a thick inner diffusion layer that can improve the fatigue properties. The carbon amount in the plasma gaseous mixture and the process temperature affect directly the morphology, microstructure, and the formation of the compound layer, and consequently affect the hardened surface layer proprieties. In a carbon-free plasma (nitriding), the predominant phase formed in the compound layer is the Fe4N phase, while for carbon-enriched plasma (nitrocarburizing), the Fe2-3N phase prevails. Excessive amount of carbon in the gaseous mixture may produce cementite (Fe3C), which can be considered hard and brittle. The diffusion zone is a supersatured interstitial solution of carbon and nitrogen in a metallic matrix. This work investigates the effects of the methane addiction in the nitrogen and hydrogen mixture, and the process temperature on the plasma modification of DIN 100Cr6 steel samples. This steel is used as raw material in the manufacture of a mechanical component applied in hermetic compressors for refrigeration. Four methane concentrations (0, 1.0, 1.5, and 2.0%) and two temperatures (550 and 600℃) were used. The samples were characterized by XRD, SEM, EDS, wear resistance, and micro-hardness tests. Microporosity layers were formed for all process conditions. For higher CH4 concentrations, the Fe2-3N phase was preferentially formed on the modified surface, yielding higher microhardness and wear resistance values. The samples treated at 600℃ presented larger surface layer thicknesses and also higher microhardness values.

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