LASER MODIFICATION OF GAS-NITRIDED LAYER PRODUCED ON 42CrMo4 STEEL

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A thorough analysis of literature data on the nitriding process of steel and other metal alloys was carried out in this paper. It was found that controlled gas nitriding is a process in which it is relatively easiest to control the nitriding potential of the atmosphere and control it in order to obtain nitrided layers with the appropriate phase composition in the shortest possible time. Simultaneously, laser modification of nitrided layers with or without melting creates new possibilities for influencing the microstructure and properties of surface layers produced on metals and their alloys. Laser heat treatment processes of nitrided layers have not yet been sufficiently developed and described, especially there is a lack of data in the literature on laser-modified nitrided layers without remelting. In this work, the controlled gas nitriding was used to produce nitrided layers on 42CrMo4 steel. The microstructure after controlled gas nitriding consisted of a compound zone ε+(ε+γ') with a thickness of approx. 20 μm or 8 μm and a diffusion zone containing nitric sorbite with γ' phase precipitates. Appropriate parameters of laser heat treatment were selected to enable the production of laser-modified nitrided layers both with and without remelting. Laser-modified nitrided layers with increased hardness and increased resistance to wear by friction compared to nitrided layers were produced. The microstructure of the hybrid layer, which was gas-nitrided and laser-modified with remelting with argon shielding consisted of a re-melted zone with coarse-grained nitric martensite, a heat-affected zone with fine-grained nitric martensite and possible precipitates of γ' phase, and a non-laser modified diffusion zone with nitric sorbite and γ' precipitates. The microstructure of the hybrid layer, which was gas-nitrided and laser-modified without remelting consisted of a compound zone ε+(ε+γ') of modified morphology, mainly in the case of the more compact and less porous ε phase, a heat-affected (partially hardened diffusion zone) with nitric martensite and possible precipitastes of γ' phase and a diffusion zone not subjected to laser modification with nitric sorbite and γ' precipitates. In some cases, there was a partial remelting of the compound zone. Thanks to the laser heat treatment of the nitrided layer without remelting, a modified microstructure and more favorable properties of the compound zone were obtained, especially in the case of the nitride zone ε ($Fe_{2-3}N$), which was characterized by greater compactness and lower porosity, which resulted in an increase in hardness and Young's modulus, were obtained. The dimensions of the laser-modified nitrided layers (the depths and widths of laser tracks) can be predicted using both numerical methods and the model of temperature distribution developed by Ashby and Esterling.