[99k] - SURFACE HARDENING BY COMBINING CR-ELECTROPLATING AND MICROWAVE RESONANCE PLASMA NITRIDING OF CUTTING POINTS OF OUTSIZED SAWS FOR WOOD INDUSTRY

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Abstract:

SURFACE HARDENING BY COMBINING CR-ELECTROPLATING AND MICROWAVE RESONANCE PLASMA NITRIDING OF CUTTING POINTS OF OUTSIZED SAWS FOR WOOD INDUSTRY

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The ability of microwave plasma generated in the single resonance mode cavity of TM013 at atmospheric pressure [1-3] to transform chromium coatings into chromium nitride and the related properties of the chromium nitriding protective layers in terms of hardness and wear resistance are demonstrated. This research and development was undertaken as applied to circular and band saws used for machining of wood and wood-based composites in order for considerable improvement their service life through the application of hard duplex coatings to cutting edges.
Circular/band saws are the most widely-used tools in wood/furniture industry for woodworking. Usually, sawing takes up to 60% in general machine processing of wood. The circular (up to 1.5m in diameter) and band (approximately 8 m long and 0.4 m with) saws are used for pre- sawing of logs.
Wood and wood-based products possess abrasive properties especially when abrasive particles such as sand or soil are incorporated in surface of wood materials. The cutting points of the saws for the preliminary sawing must be hard and wear/corrosion resistant; otherwise the saws keep their workability a few hours only. Further replacement and set-up of the saws require a longtime stoppage of saw utensils that leads to losses of time/materials and, therefore, profit. In order to get better wear/corrosion resistance of wood cutting tools, different kind of hardening the cutting points of the saws are used, such as melting/soldering of inserts manufactured from hard alloys (satellites, high speed steels, etc) and hard composite materials (WC-Co, cermets, etc).
Recently hard coatings such as diamond-coated demented carbides [4], duplex treatment [5], chromium nitride [6-8], and titanium nitride [8] are deposited on

cutting tools for wood machining. The performance of wood cutting tools was considerably improved. A duplex treatment consisting in nitriding followed by CrN-sputtered coatings that allowed to increase twice tools service life was well established elsewhere [5]. The CrN-based duplex treatments demonstrated a better performance in comparison with TiN-based duplex treatments.
Chromium nitride coating has replaced TiN-coatings because CrN-coating has lower friction coefficient and better wear/corrosion resistance. However, these technologies are impossible to apply for the above-mentioned outsized saws because the technologies are vacuum-based ones, which have limited volume/dimensions of chamber (approximately 0.25 m3), that does not allow such surface treatment of the outsized saws. Here a novel chromium-based duplex treatment to increase abrasive resistance of the outsized saws has been developed. This technology will be discussed as an industrial application of microwave resonance plasma in wood industry.
At the first stage, chromium-electroplated coating, which is cheep well-established finish, is deposited on a tool steel substrate, which is hard as 450-500 HV0.05. Adhesion to steel substrates is usually improved by the deposition of the 0.1-0.5 μm-thick Ni intermediate layer, which forms an optimum width of the interface, facilitates to corrosion resistance as well. The measured microhardness of Cr-electroplated layer of 10-12 μm thick was within 900-1100 HV0.05.
At the second stage, the chromium-electroplated coating has been transformed by the microwave resonance plasma torch operating at atmospheric into chromium nitride. Operational parameters of MRPS for nitriding of Cr-coating were as followings: forward microwave power – 800 W, gas flow of pure nitrogen or air – 1-5 l/min. The microhardness of chromium nitride was measured in a range of 1900-2100 HV0.05, and a coefficient of friction in the range of 0.1-0.15.
Finally the multi-component graded coatings on steel substrates were composition of Ni-Cr-CrN from bottom to top. Such compositional grading allows achievement of both high hardness and good adhesion for tribological applications. Therefore microhardness gradually increased from 450-500 HV0.05 for tool steel substrate till 1900-2100 HV0.05 for chromium nitride.
In this preliminary study the feasibility of microwave plasma nitriding the cutting tips of outsized saws followed by Cr-electroplating is reported. Preliminary results show that it is possible to produce the hard facing composite coating for wood cutting tools. In view of these results, there is a scope to optimize the Cr-coating for the woodworking applications where the coatings are subjected to extreme conditions of wear. This novel chromium-based treatment established on microwave plasma nitriding is firstly out of dimension limits and secondly cheaper approximately by factor of five than the conventional vacuum-based one.

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