SOME STUDIES ON LASER BORIDING OF NICKEL AND CHROMIUM ELECTROPLATED AISI 1020 STEEL

A THESIS

Submitted by

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ABSTRACT

Chapter one introduces the significance of boriding as an effective surface modification technique to improve the surface hardness of steels.

Chapter two presents a literature review of boride surface modifications of steels. It focuses on the problems associated with boride layer developed using thermo-chemical boriding processes, influence of alloying elements on structure and properties of boride layer and different methods recommended by various researchers to lessen the brittleness of the boride layer.

Chapter three addresses the scope of the present research and its objectives. The hub of the present research was to develop a fairly less-brittle boride layer on AISI 1020 steel with a surface hardness in the range of 1300 HV-1500 HV without much reduction in the core properties as compared with continuously pack borided and interrupted pack borided specimens. Also, it should have adequate wear and corrosion resistance. Hence, multicomponent (Ni + Cr + B_4C) laser boriding was attempted. This is a three-stage process (Ni electroplating followed by Cr electroplating and then laser boriding using B_4C powder). The process may also be termed as laser boro-carbo-chromo-nikelising. The structures and properties of multicomponent laser borided layer were compared with continuously pack borided and interrupted pack borided specimens.

Chapter four describes the experimental methods adopted in the study.

Chapter five elucidates results of the experimental study and discussions on the findings of the research work.

A carbon steel of grade AISI 1020 was selected as the base material. The surface of the AISI 1020 steel was modified by three different boriding processes i.e., continuous pack boriding, interrupted pack boriding and multicomponent (Ni + Cr + B_4C) laser boriding. Continuous pack boriding was carried out in a muffle furnace at 950°C for 3 h in a boriding mixture. Interrupted pack boriding is a modified pack process. The packing procedure is similar to continuous pack boriding, but the difference is in the heat treatment cycle of the process. The specimens were subjected to heating at 950°C for 1 h. After 1 h of boriding, the stainless steel box containing mixture of SiC and specimens were removed from the furnace and allowed to cool in still air for 45 min and then it was again loaded in the muffle furnace. This procedure was repeated 3 times. Laser boriding was carried out on nickel and chromium electroplated specimens at different energy densities by keeping laser power at 500 W, at different scanning speeds and at two different spot diameters 1.5 x 10^{-3} m and 1.62 x 10^{-3} m. The energy densities of the laser beam were varied from 19 x 10^6 J/m^2 to 85 x 10^6 J/m^2. The structures of the multicomponent laser borided specimens obtained by different energy densities of laser beam treatment were evaluated by optical microscopy, XRD, SEM and EDS. The properties of multicomponent laser borided layers were estimated from Vickers microhardness testing (to estimate microhardness and fracture toughness), charpy impact test (to estimate impact toughness and percentage of ductile shear fracture area), tribometer (to estimate co-efficient of friction,