ABSTRACT

AISI H13 steel, owing to its intrinsic characteristics of good resistance to thermal fatigue, erosion, and wear, is widely used in high-temperature applications like forging, extrusion, pressing, and casting dies. To enhance the service life in severe working conditions, various surface modification techniques, including laser surface modification through transformation hardening, remelting, alloying, and cladding with different kinds of materials have been much researched. In the current work, some of the least investigated aspects of laser surface remelting and laser cladding with Co-based Stellite alloys and composite have been studied. Through the online monitoring of the thermal history in laser remelting, the effect of laser process parameters on it was studied, and the width and the depth of remelted zones were correlated with the molten pool thermal history. The effect of the thermal cycle on microstructure, microhardness, and wear of laser melted surfaces was investigated. Next, H13 steel samples were hard-faced by laser cladding with Stellite-6 and Stellite-6 +30 wt% WC composites. A comparative study of the ball-on-disk sliding wear behaviour of laser remelted H13 steel and Stellite-6 cladded surfaces at room and elevated temperatures were done, and interestingly it revealed less wear loss in laser remelted surfaces compared to Stellite cladding. With increasing temperature, wear loss increased due to softening of the materials. The effect of oxidation was also studied by conducting tests in a normal atmosphere and high vacuum at elevated temperatures. However, the high-temperature 3-body abrasive wear tests conducted on all the three types of modified surfaces revealed higher wear in laser remelted surfaces than in Stellite cladded surfaces, and the wear increased with temperature. The wear loss in Stellite-6/WC composite was the lowest and marginally varied with no definite trend with temperature. The bonding strength of laser cladding of Stellite-21 on H13 substrate was also investigated for different laser clad track strategies and laser line energy. The laser clad tracks deposited along the direction of the shear stress and a relatively higher laser line energy yielded higher bonding strength. The bonding strength was more than that of the H13 steel material, and with the thermal cycle, the strength was reduced. Various mechanical and metallurgical characterizations were done to understand all experimental observations.

Keywords: Laser surface remelting, laser cladding, AISI H13 steel, Stellite alloy, Stellite/WC composite, High-temperature ball-on-disc wear, 3-body abrasive wear, bonding strength