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The Mechanics of Hardening and Roughening during the Incubation Period in Water Droplet Erosion

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ABSTRACT

In the present work, the role of dynamic surface hardening and roughening on the damage accumulation during the incubation stage in water droplet erosion (WDE) is investigated. Water droplet erosion tests were carried out on Ti-6Al-4V alloy at an impact velocity of 250m/s. The evolution of hardness and surface roughness during the incubation period were evaluated using microhardness tester and Confocal Laser Scanning Microscope (CLSM). Scanning Electron Microscopy (SEM) was also conducted on the impact area at several intervals during the incubation period. Based on the SEM micrographs, Finite Element (FE) simulations were then performed to obtain the impact stresses on smooth and rough surfaces. It was found that the solid surface plastically deforms by the action of initial impingements, and as a result, hardness and surface roughness increase progressively until the end of the incubation period. The increase in hardness renders the material stronger and more resistant to subsequent droplet impacts, hence, preventing damage build-up. However, the finite element results revealed that the dynamic surface roughening process results in a continuous increase in impact stresses due to geometrical stress concentration. Hence, the increase in impact stresses -for the same impact pressure- resulting from surface roughening negates the improvement in erosion resistance due to hardening. As such, roughness is an essential parameter in predicting the length of the incubation period.

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