A comparative study on the sliding wear behaviors of human tooth enamel, Cu-Zn alloy and Al2O3 ceramic


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Given that human tooth enamel contains 92-96 wt% inorganic substances, it is often considered as a biological ceramic material. However, recently a few studies have indicated that the unique composition and microstructure of enamel result in its nanomechanical performance similar to that of metal materials. To extend the understanding of enamel wear mechanism, the sliding wear behavior of human tooth enamel has been studied by comparing it with that of Cu-Zn alloy and Al2O3 ceramic in this paper, using a reciprocating horizontal tribometer. Wear tests up to 5 000 cycles were conducted continuously under two conditions respectively: dry condition and distilled water lubrication. Wear was assessed by sample wear volume. It was noticed that an elliptical wear scar appeared on the surface of either enamel or Cu-Zn alloy after 5 000 cycles, but the wear scar on the surface of Al2O3 ceramic was flatly elliptical and irregular in outline. For the enamel and Cu-Zn alloy, the wear morphologies under both conditions were characterized mainly by ploughing effect accompanied by delamination pits, and the wear volume was obviously smaller under distilled water lubrication than under dry condition. For the Al2O3 ceramic, obvious flake delamination happened on its worn surface under both wear conditions, and the wear volume was contrarily bigger under distilled water lubrication. In summary, in terms of the wear morphology and the response to water lubrication, the sliding wear behavior of human tooth enamel was more similar to that of the ductile material of Cu-Zn alloy than that of the brittle material of Al2O3 ceramic. The results would be helpful to fully understand the effect of enamel composition and microstructure on its tribological properties.

Keywords: Human tooth enamel, Cu-Zn alloy, Aluminium oxide ceramic, Wear behaviour