Characterization of tribofilms and the effect of countersurface roughness for carbon fiber reinforced PTFE composites in trace moisture environment

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To meet the needs of the emerging field of hydrogen and fuel cell technologies, reliable and efficient compression of hydrogen gas is needed. One of the key components in reciprocating gas compressors are the piston rings, commonly made of carbon fiber (CF) reinforced PTFE composites. The amount of research on PTFE/CF composites in trace moisture environments and the high sliding speeds present in hydrogen gas compressors are extremely limited. In this work, the tribofilm formation and running-in behavior of PTFE/CF composite – steel tribopair were studied for different roughness of the countersurface. Tribotests were conducted in a tri-pin-on-disc tribometer in a controlled nitrogen environment. Results showed that the friction behavior varied significantly with roughness during running-in, even though the effect of roughness on the average coefficient of friction was insignificant during steady-state conditions. The transient wear of the PTFE/CF composite was also affected by roughness, where wear decreased with lower roughness. Analysis of the countersurface from different stages of running-in revealed a significant difference in the formation of the transfer film formed on a smooth and rough countersurface. With a rough countersurface, an easily removable transfer film is transitionally formed before subsequently being replaced by a persistent transfer film. However, with a smooth countersurface, a persistent transfer film starts to form directly. On the PTFE/CF surface, a tribofilm was formed after sliding against both a rough and a smooth countersurface. Observations show that this tribofilm is a few micrometers thick and exhibit exceptional low-friction properties.

Keywords: PTFE, Carbon fiber, Running-in, Tribofilm, Roughness

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