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In situ studies of TiC1-xNx hard coating tribology

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It is known that ceramic coatings with substantial amounts of structurally incorporated carbon show low-friction behavior, in particular at intermediate temperatures. However, the mechanisms behind activation, formation and modification of the required free carbon in the friction contact are still not fully understood, especially in the case of TiC1-xNx, a widely used commercial coating. In previous studies it was shown that a transfer layer that adheres predominantly to the counterpart is formed regardless of the surrounding atmosphere, but only when moisture is present, Raman spectroscopy revealed C-H vibrations appearing simultaneously with the low-friction regime. Tribological tests at different relative humidity levels revealed that a minimum value between 15 and 25 % RH is needed for the formation of these C-H bonds. However, certain details remained unaddressed due to the use of post mortem analysis methods: i) how does the transfer film form?; ii) which role does the running-in plays in its formation?; iii) where exactly does sliding occur? In order to answer these questions, in situ tribometry is necessary. By in situ observations of transfer film growth, we observed that third body material was formed during the running-in period by plowing of the coating and shearing of the removed material. The appearance and thickening of the transfer film marked the beginning of the steady-state low friction regime where the velocity was accommodated by interfacial sliding. At this stage in the tribological test, the recorded Raman spectra indicated the presence of C-H bonds in the wear track. In summary, use of in situ analytical tools during wear tests provided insights into tribological phenomena that were not available by conventional, post mortem analysis methods.

Keywords
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