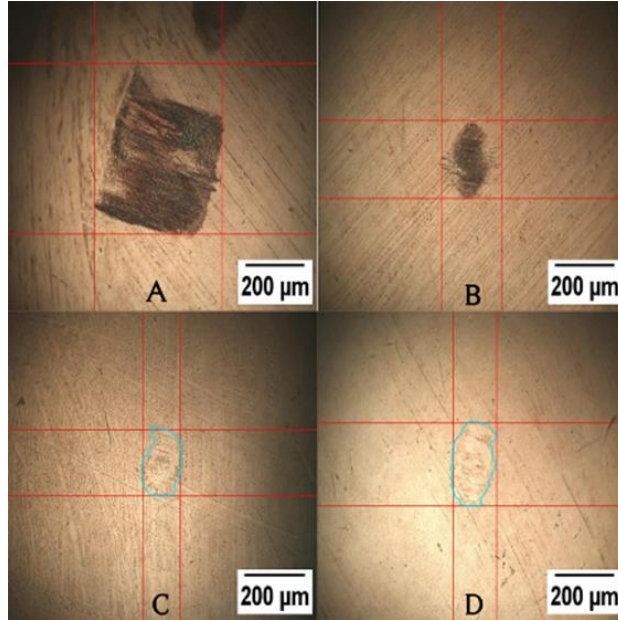
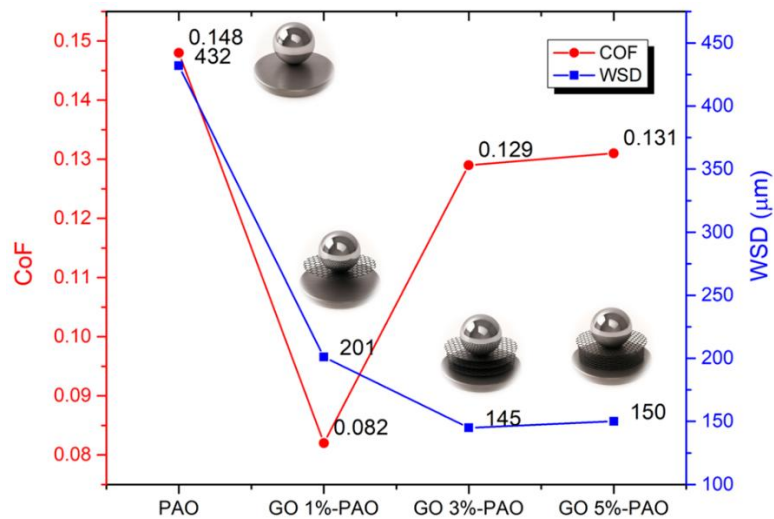


## Supplementary file



**Figure 9.** The HFR test results also show the WSD on the steel ball surfaces after lubrication with: (A) pure PAO oil, (B) GO 1wt%-PAO, (C) GO 3wt%-PAO, and (D) GO 3wt%-PAO. The images illustrate the progressive reduction in wear scar size with increasing GO content, indicating enhanced antiwear performance due to the formation of protective tribofilm facilitated by GO additives.



**Figure 10.** Comparison of the CoF and WSD values for four lubricant samples: pure PAO, 1%, 3%, and 5% additives. The graph illustrates the tribological performance under identical test conditions.