Responses to reviewers' questions:
Reviewer: Dr. Dorina Kovacs, PhD

Dear Reviewer,

Thank you for review my dissertation. I have carefully addressed and answered all the questions raised. For clarity, the questions presented in **bold**, and my responses in regular font, as shown below:

- **Figure 34 presents an elemental line scan of the worn surface; however, the data remains noisy. In particular, Figure 34a shows a high value, though it is unclear where the measurement was taken. This should be clarified by marking the scan line on the figure. The same issue applies to Figures 35 and 37.**

  Thank you for your question. The elemental line scan analysis presented in Figures 34, 35, and 37 was conducted to characterize material loss along the wear tracks. While some of the data—particularly in Figure 34a—appear noisy, this is not due to measurement error, but rather reflects minimal or highly localized wear. For instance, in Figure 34, a slight fluctuation in carbon content around the 400–800 µm region indicates that the TiN coating was only partially removed in this area.

  Regarding the location of the measurement, I would like to clarify that the EDS scan was performed at the center (middle) of each image. While the scan line was not physically marked on the figures, it represents a virtual line used during the EDS analysis, and its central location can be clearly understood from the context provided in the descriptive paragraphs (please see section 5.5, Surface morphology and roughness analysis, p. 56). This line crosses the wear track, and the elemental compositions were recorded at 10 µm along that path in all cases. The EDS scan was specifically selected to capture the full width of the wear groove and the underlying elemental variations across the worn surface.

- **What is the explanation for the increase observed at the end of the curve in Figure 36.**

  Thank you for your observation. The slight increase in wear rate at the end of Figure 36 (750–1550 m) is attributed to the partial detachment of the TiC coating (second protective layer), which likely began after prolonged sliding. This detachment exposed localized areas and introduced hard wear particles into the contact zone. These particles contributed to an abrasive wear process and slightly increased the wear on the zirconium ball due to accumulated debris.

- **A modification to the thesis title was previously suggested. If the candidate could define "cutting efficiency" in a way that does not use actual cutting tests, the title would be considered acceptable.**

  Thank you for the comment. Based on our investigation of the performance of bilayer TiN/TiC CVD coatings and TiN-based CVD coatings in both single and multilayer configurations—specifically their effects on adhesion performance, tribological behavior, wear resistance, oxidation stability, and microhardness—we define cutting efficiency as the expected functional performance of the coating under conditions relevant to cutting applications.

We acknowledge that direct cutting tests were not performed. However, the selected evaluations—including high-temperature oxidation, hardness degradation, surface roughness evolution, adhesion performance, tribological behavior, and wear volume analysis—are widely recognized as indirect predictors of cutting tool performance, particularly under high thermal and mechanical loads. Therefore, the use of the term "cutting efficiency" in the title reflects the inferred performance of the coatings based on experimentally validated properties that are directly related to service behavior in cutting environments.

Additionally, I would like to clarify that, at this stage, modify the dissertation title is difficult after the final official submission.

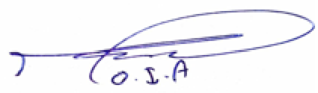
- **Regarding the oxidation test, the candidate stated that *during the first five cycles, the oxidation time was 2 minutes per cycle; the sixth cycle had a duration of 10 minutes, and the seventh cycle was extended to 20 minutes*. How could the candidate decide the oxidation test method? Is it based on a standard procedure? Furthermore, does the type of oxide formed on the surface influence the interpretation of results, and has this been considered in the analysis?**

  Thank you for this question. The oxidation test method used in this study was developed according to experimental approach rather than a fixed standard. The decision to use varied oxidation times—starting with short 2-minute cycles and later extended to 10 and 20 minutes—was based on observations of elemental changes in the coatings during the early stages of oxidation.

  In particular, during the initial cycle (2 minutes), the oxygen content increased from 25.54 to 53.30 at.% for sample A, and from 27.78 to 59.96 at.% for sample B (see Figures 41 and 42). These significant increases in oxygen content indicated highly active surface reactions; therefore, short durations were used to monitor rapid chemical changes during these stages. As oxidation progressed, the rate of compositional change slowed (especially between cycles 2 and 5), due to reduced oxidation activity under short exposure times. Therefore, longer durations (10 and 20 minutes) were applied in the sixth and seventh cycles to detect any remaining elemental changes without unnecessary repetition of minimal variations. Notably, oxidation tests were stopped after 40 minutes, as oxygen content stabilization was observed during the sixth/seventh cycles, indicated a stop of oxidation activity. This approach ensured scientific accuracy while maintaining time and resource efficiency.

  Regarding the second part of the question: yes, the type of oxide formed on the surface significantly affects in the interpretation of results, and this was thoroughly considered. For example, the formation of rutile TiO_2 was confirmed by XRD (see Figure 43), indicating that the hard-TiN surface layer had completely transformed into titanium oxide. This transformation was directly correlated with reductions in microhardness and changes in surface integrity, as observed in the post-oxidation analysis.

Veszprém, 18 June, 2025



PhD student

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