INTERNATIONAL JOURNAL OF AUTOMOTIVE AND MECHANICAL ENGINEERING
ISSN: 2229-8649 e-ISSN: 2180-1606
VOL. 21, ISSUE 2, 2024, 11302 – 11315
DOI: https://doi.org/10.15282/ijame.21.2.2024.10.0873

RESEARCH ARTICLE

A Comparative Study of Dry Turning Performance of 4340 Alloy Steel with As-Received and Cryogenically Treated Coated Cermet Cutting Tools

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ABSTRACT - Cryogenic treatment has been shown to significantly improve the cutting performance of inserts. Alloy steel grade 4340, renowned for its high impact and abrasion resistance, has extensive application in aircraft landing and high-power transmission gears. In this study, a comparative characterization (microhardness and XRD profile) and dry turning performance evaluation (turned surface roughness and insert wear) of alloy steel grade 4340 were performed using as-received and cryogenically treated coated cermet cutting inserts. The turning operation was carried out with various cutting velocities (55, 90, and 150 m/min) and a constant feed and cutting depth (0.111 mm/rev and 1 mm) under dry cutting conditions. The cryogenically treated insert obtained A reduced R_a value compared to untreated conditions at all cutting speeds. In addition, R_a value was reduced to a maximum of 29%. A lower level of insert wear and chip particle deposition at the cutting point was observed with cryo-treated inserts. Finally, it was revealed that the better machining characteristics in terms of reduced R_a values and insert wear with cryo-treated conditions were due to the enhanced wear resistance over the untreated conditions.

ARTICLE HISTORY
Received : 12th Jan. 2024
Revised : 03rd Apr. 2024
Accepted : 27th May 2024
Published : 20th June 2024

KEYWORDS
AISI 4340 steel
Cermet insert
Cryo-treatment
R_a parameter
Insert wear

1.0 INTRODUCTION

The alloy steel is widely used in various manufacturing components due to its excellent mechanical properties and low cost [1]. In this category, 4340 alloy steel is primarily used in gears of aircraft landing, shafts and gears of power transmission, crankshafts, and other machine tools [2,3] because of its better characteristics, such as higher strength, ductility, stiffness, toughness, and resistance to wear and fatigue [4,5]. 4340 alloy steel is difficult to cut because of its strength and tendency to work hard [6]. Therefore, the machining should be carried out in a wet environment to get a better finish and accuracy. However, the use of coolants during machining causes various problems, such as regular maintenance and disposal of these fluids, various operator health hazards, and environmental issues due to government regulations, which increase the cost of production. Therefore, various production industries shape 4340 alloy steel in dry-cutting conditions to get a product at a low cost. In addition, the industry is targeted towards the dry environment to avoid environmental issues. In reality, the dry-cutting environment is less effective due to its poor machinability characteristics, such as poor finish and high insert wear. In this environment, a supplementary technique, such as cryo-treatment of the insert, is required to enhance the machining characteristics through the improvement of hardness and wear resistance [7,8]. Cryo-treatment is an eco-friendly and efficient method [9], which enhances the machining characteristics as well as the overall machining process [10,11].

Avila and Abrao [12] investigated the turning performance of 4340 alloy steel with mixed alumina (Al_2O_3+TiC) under dry conditions and when various coolants were used. They reported that dry and emulsion-based coolants without mineral oils provided better performance than synthetic and emulsion-based coolants with mineral oils. Lima et al. [13] revealed the machining characteristics of 50 HRC and 42 HRC hardened 4340 alloy steel with PCBN and coated carbide inserts, respectively. For 42 HRC steel, force and roughness decreased when cutting velocity decreased. When using the carbide inserts, the rate of wear was increased significantly due to abrasion while turning the 42 HRC steel. For 50 HRC steel, the wear rate was higher with the PCBN tool due to diffusive wear. More et al. [14] studied the impact of input parameters on the finish, forces, and life of inserts when turned 4340 alloy steel by PCBN and cBN-TiN coated inserts. They reported that the coated insert provided enhanced life and a better finish than PCBN inserts. Based on cost analysis, they also reported that the machining cost was reduced with coated inserts instead of others. The effect of minimum quantity lubrication (MQL) on carbide tool wear and the finish of 4340 alloy steel was investigated by Dhar et al. [15]. They revealed that MQL offered a lower rate of wear and roughness than dry and wet environments.

Sahoo and Sahoo [16] investigated the hard turning performance of 4340 alloy steel using uncoated, multilayer TiN/TiCN/Al_2O_3/TiN and ZrCN inserts. Improved performance was obtained with multilayer TiN-coated inserts in terms of saving machining costs by 93.4% and 40% over uncoated and ZrCN-coated inserts, respectively. A lower cutting force was required for turning 4340 alloy steel with CVD - TiC/TiCN/Al_2O_3 coated inserts at a higher cutting speed, low feed, and cutting depth combination, as reported by Suresh et al. [17]. They reported that with an increase in speed and feed, the tool wear and power required were increased. In addition, at high-speed and low-feed combinations, a better finish was obtained. In all cutting combinations, abrasion was the primary wear mechanism. The effect of input parameters and

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coated inserts on cutting temperature while turning alloy steel (4340) was studied by Chinchanikara and Choudhury [18]. They reported that the PVD (TiAlN) tool generated a lower interface temperature than CVD (TiCN/Al_2O_3/TiN) inserts. Agrawal et al. [19] predicted the roughness values of turned 4340 alloy steel with a CBN insert by using various regression models (multiple, random forest, and quantile regression). They reported that the random forest regression model was a better choice than others.

Orra and Choudhury [20] developed the flank wear model by using the adaptive feedback linear control method while cutting 4340 alloy steel with a TiAlN-coated ceramic tool. They reported that a simulated value of tool life was in good agreement with the experimental value. Khan and Bhivsane [21] investigated the effect of nose radius and cutting parameters on the finish of turned surfaces of 4340 alloy steel by using TiN-coated CBN inserts. They reported that the radius of the nose was a more influential parameter for the finish of the product than the cutting parameters. The performance of CVD-TiN/Al_2O_3/TiCN and PVD-TiCN carbide inserts while turning 4340 alloy steel under dry conditions was investigated by Ginting et al. [22]. They concluded that multilayer CVD is suitable for rapid metal removal, but monolayer PVD is suitable for finishing. The turning characteristics of 4340 alloy steel with a multilayered coated carbide tool under dry and MQL conditions were studied by Das et al. [23]. They reported that the MQL environment provided a higher surface finish and lower tool wear than dry conditions.

Boing et al. [24] reported that based on tool life, PVD-TiAlN coating provided better tool life for AISI 4340 steel, but CVD-TiCN/Al_2O_3/TiN coating for AISI 52100 and D2 steels. The impact of a micro-textured or grooved WC insert on force, friction, and insert wear when cutting alloy steel of 4340 was studied by Patel et al. [25]. A micro-grooved tool exhibits a beneficial effect on the above-mentioned output responses over others. Das et al. [26] revealed the cutting characteristics of the alloy steel grade 4340 using an uncoated cermet insert under four different compositions (ZnO, CuO, Fe_2O_3, and Al_2O_3) of MQL nanofluids. The best to worst was in the order of CuO, ZnO, Fe_2O_3, and Al_2O_3. Singh et al. [27] studied the chip morphology and finish of the turned surfaces of alloy steel grade 4340 steel by ceramic insert. They reported that the developed ceramic inserts provided the discontinuous chip with a better finish at these optimum cutting conditions, such as 250 m/min, 0.20 mm/rev, and 0.5 mm.

Raof et al. [28] investigated the microstructure of turned surfaces of alloy steel grade 4340 by CVD-coated (TiCN and Al_2O_3) carbide inserts in dry and cryogenic conditions. A cryogenically turned surface provided the ultrafine with globular particles, which improved strength and hardness over dry conditions. Jiang and Wang [29] investigated the various wiper cutting-edge geometries over conventional during orthogonal turning alloy steel grade 4340 by finite element simulation. A peak cutting temperature and forces were increased with wiper tools over the experiment results, but the temperature distribution on the edge of the tool was reduced, which reduced the tool wear. Das et al. [30] evaluated the performance of hard-turning 4340 steel with an uncoated cermet insert under different cooling conditions. The best performance was achieved with nanofluid over others. Sarjana et al. [31] recommended that the cutting tool for finishing the turning of alloy grade 4340 was uncoated and coated cermet tools over coated carbide tools and also that the best optimum cutting conditions to achieve higher productivity were at 120 m/min, 0.1 mm/rev, and 0.2 mm. The turning parameters of alloy steel 4340 with a high-speed steel tool were optimized based on roughness values using various techniques by Santhosh et al. [32].

An impact of turning parameters and nano-lubricants (Al_2O_3 and CuO were mixed with rice bran vegetable oil, respectively) while cutting alloy steel grade 4340 with uncoated cermet inserts was investigated by Elsheikh et al. [33]. They concluded that CuO/oil nanofluid provided smooth surfaces with less insert wear than others. Khatir et al. [34] investigated the impact of turning parameters and laser power on the turned surface of alloy steel grade 4340 with carbide inserts. They reported that feed and laser power mainly affected surface integrity compared to others. You et al. studied the resistance to wear of various CVD coatings of cermet substrate and the turning performance of alloy steel grade 4340 [35]. They reported that the TiCN/Al_2O_3 coating provided the best overall performance over others.

Akıncıoğlu et al. [36] evaluated the impact of shallow and deep cryo-treated tungsten carbide tools during the turning of Hastelloy C22 alloy. They reported that both cryo-treatments increased the wear resistance of WC inserts, which reduced the roughness of turned surfaces over untreated conditions. Chetan et al. [37] revealed that the reduced flank wear, cutting forces, and chip-tool contact length with cryo-treated tungsten carbide and AlTiN-coated carbide inserts during dry turning Nimonic 90 alloy overcame the received conditions of the inserts. Senol et al. [38] reported that cryogenically treated uncoated carbide tools performed slightly better than untreated tools during the machining performance of Inconel X750 alloy. Deshpande et al. [39] reported that turning Inconel 718 with a cryo-treated coated WC tool provided a substantial enhancement in surface finish and tool life by 10% and 19%, respectively, over the received conditions of inserts. Dhananchezian [40] noted the favorable dry-turning performance of Monel 400 alloy with cryo-treated AlTiN-coated carbide inserts over the received conditions of inserts. From the previous literature review based on turning with the cryogenic treatment of cutting tools, it is evident that the cutting performance has been enhanced with cryo-treated cutting tools over untreated conditions.

From the summary of the literature review, it is evident that the majority of the turning of AISI 4340 was carried out with a cermet tool in an MQL-nano lubricant environment. However, the machining industry demands the cutting of hardened alloy steel (AISI 4340) in a dry environment. In addition, from the existing literature review based on turning with the cryogenic treatment of cutting tools, it is evident that the cutting performance has been enhanced with cryo-treated tools by an increase in hardness and wear resistance over untreated conditions in a dry environment. Based on the above-mentioned existing journals and also to the author's knowledge, there is no study to investigate the dry turning performance of AISI 4340 alloy steel with cryogenically treated inserts, which is essential for the machining industry. Therefore, the purpose of the current work is to study the impact of cryo-treatment on hardness, XRD profiles, and the most important machining responses of roughness and wear mechanisms of cryogenically treated cermet inserts during the turning of alloy steel grade 4340.

2.0 MATERIALS AND METHODS

An alloy steel of AISI 4340 cylinder (Ø 38 × 200 mm) was used as work material in this study. A coated cermet (PVD-TiN/TiCN/TiN) grade of CNMG 120408 FW (KT 315) (WIDIA) was used in this work. In this cryogenic treatment method, the insert temperature was lowered from 30ºC to -196ºC with a cooling rate of 0.5ºC/min, soaked at -196ºC for 24 hours, and then gradually from -196ºC to 30ºC with a heating rate of 0.5°C/min. After cryo-treatment, oil tempering was carried out at 140ºC with a soaking period of 2 hours. The total cycle time for cryogenic treatment and tempering was 72 hours. Figure 1 describes the cryogenic treatment method for cutting inserts. The hardness of the insert was evaluated using Micro-Vickers Hardness (HV 1). Phase analysis of cutting inserts as-received and cryogenically treated conditions was examined by X-ray diffraction with the position [°2θ] (Cu).

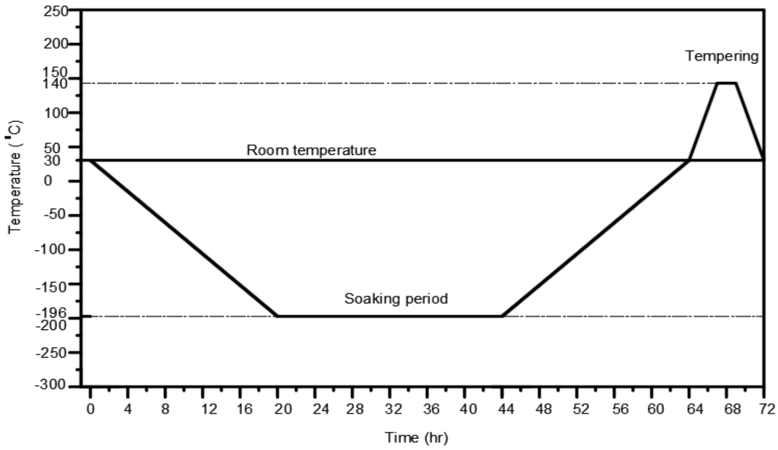


Figure 1. Procedure for cryo-treatment method

Figure 2. Photographic view of the experimental setup

A turning machine (UNITECH-MTT 636) with a maximum speed of 2000 RPM was used to carry out the cutting operations (refer to Figure 2). A dry turning of alloy steel grade 4340 was carried out using untreated and cryo-treated coated cermet inserts with various cutting speeds. The turning parameters employed were 55, 90, and 150 m/min, a feed of 0.111 mm/rev, and a 1 mm cutting depth. Samples were turned at 35 mm of cutting length. The specifications of used materials and cutting conditions are listed in Table 1. The surface roughness (R_a) parameter was measured at three different places using the SJ-210 roughness tester, and the average values were reported. An insert wear mechanism was examined using SEM (ZEISS-made EVO 18 model). The schematic representation of the methodology section is illustrated in Figure 3.

Table 1. Specification of used materials

Machine tool	Lathe (UNITECH - MTT 636)		
		Speed,	70 - 2000 RPM
		Feed,	0.067 – 1.019 mm/rev
Machining operation	Turning		
Workpiece material	AISI 4340 alloy steel		
		Diameter	- 38 mm
		Length	- 200 mm
Tool holder	PCLNR 1616 H12		
		Type of tool	- Right Hand
		Insert type	- CN - - 1204 - -
		Shank	- 16 × 16
		Clamp type	- Lever Lock
Tool material	TiN/TiCN/TiN coated cermet (CNMG 120408) grade of KT 315		
		C - Shape, Rhombic 80º	
		N - Clearance	
		M - Tolerance	
		G - Clamping	
		12 - Insert size, Insert length is 12 mm	
		04 - Insert thickness is 4 mm	
		08 - Corner radius is 0.8 mm	
		KT 315 - Multilayer PVD- TiN/TiCN/TiN	
Cutting parameters	Cutting speed	- 55, 90, and 150 m/min	
	Feed	- 0.111 mm/rev	
	Depth of cut	- 1 mm	
	Cutting length	- 35 mm	
	Environment	- Dry condition	

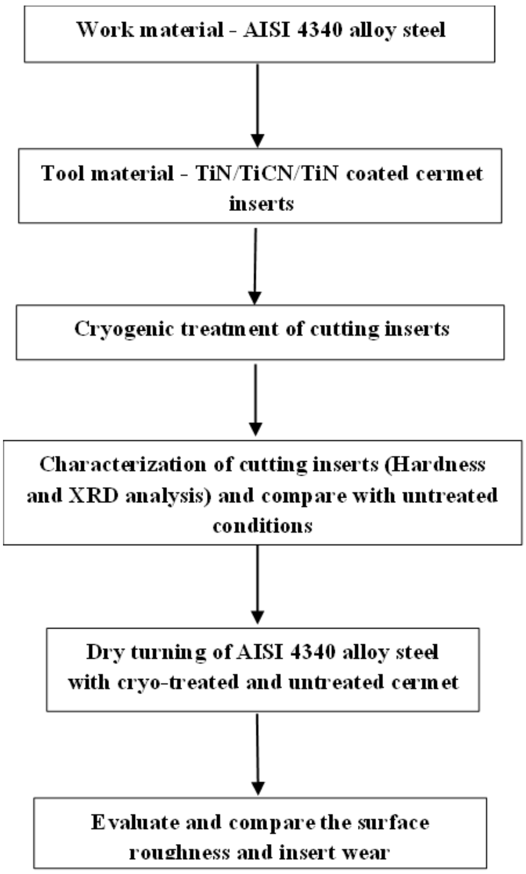


Figure 3. Schematic diagram of the methodology section

3.0 RESULT AND DISCUSSION

3.1 Microhardness

The Vickers hardness testing using a diamond indenter [IS 1501 (Part-1); 2020] was used to estimate the hardness (HV 1) of untreated and cryo-treated PVD-TiN/TiCN/TiN coated cermet inserts. For this hardness measurement, one of the sides of the rhombic 80º geometric shape of the cutting insert, representing a rectangle of 12 mm length and 4 mm thickness, was used. The microhardness was measured at the insert thickness side along the direction of length from the corner edge to 3 mm, 6 mm, and 9 mm at a distance of 2 mm from the top, as shown in Figure 4. The mean microhardness value of the three specimens (three trails) is represented in Table 2. It was revealed that cryo-treated conditions offered higher hardness values compared to the as-received conditions of cutting inserts in all cases. The reason was because of the formation of sharp and small peaks at 70–80º with cryo-treated conditions over untreated. The mean Vicker's microhardness (HV1) values of the PVD-TiN/TiCN/TiN coated cermet insert with untreated and cryo-treated conditions were 1703 and 1691, respectively. In addition, it was found that the cryogenically treated coated cermet insert increased the average microhardness value by 0.7% when compared with the received one. A similar kind of result was reported by many researchers [37,41,42].

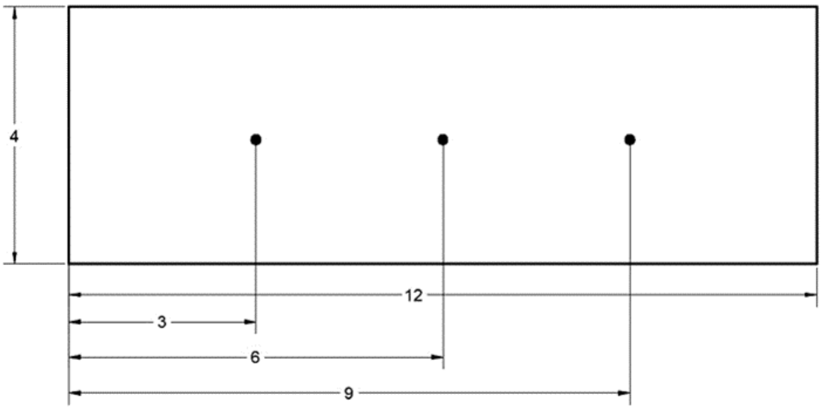
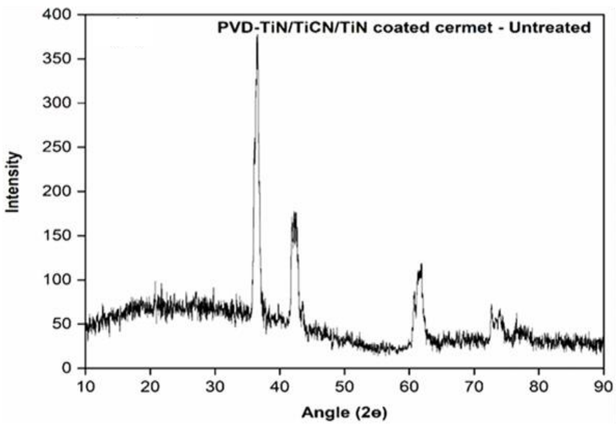


Figure 4. Geometric shape cutting insert with the location of hardness measurement (in mm)

Table 2. Hardness of coated cermet insert

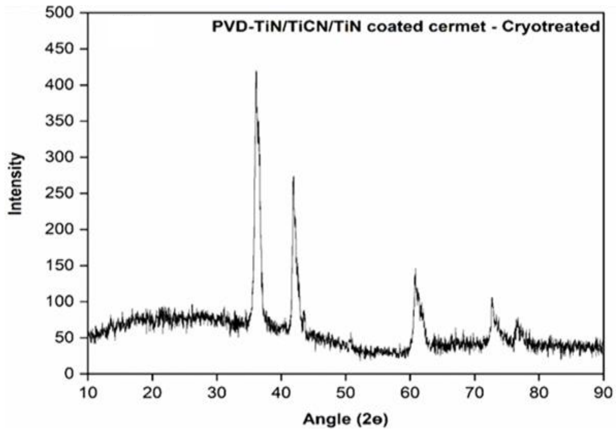
Trails	Microhardness (HV1)	
	Untreated	Cryo-treated
1	1688	1700
2	1693	1703
3	1693	1705

3.2 XRD Profile



(a)

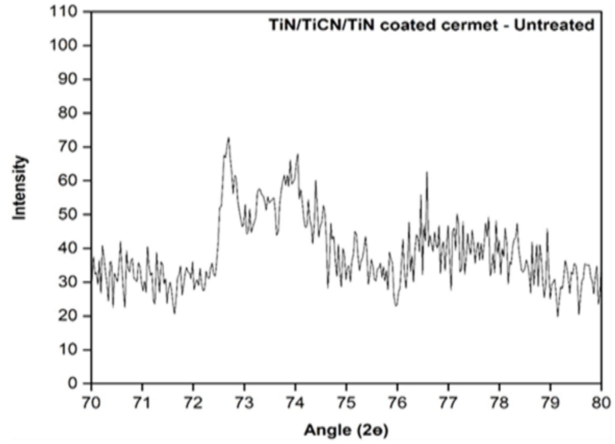
Figure 5. XRD profiles of TiN/TiCN/TiN coated cermet inserts: (a) untreated



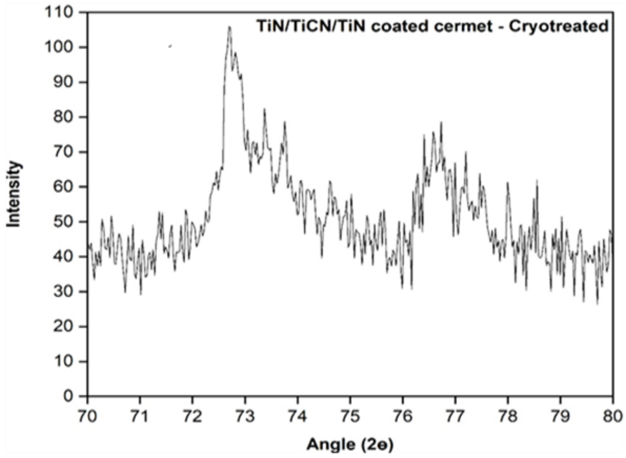
(b)

Figure 5. (cont.) (b) cryo-treated

Figure 5 shows the XRD profiles of as-received and cryogenically treated coated cermet inserts. Based on XRD profiles, it was revealed that the peaks were observed at 36º, 42º, 44º, 61º, 73º, and 74º in both cases of coated cermet inserts. However, a higher peak intensity was observed with cryo-treated cutting inserts than with untreated conditions. In addition, when compared to the as-received condition of inserts, a new peak was observed at 77º with cryogenically treated coated cermet inserts. To confirm this, extended versions of XRD profiles of 70º - 80º as received and cryo-treated inserts are illustrated in Figure 6. In addition, it was revealed that there were small, sharp peaks from 73º to 79º with cryogenically treated inserts over untreated ones. The presence of small, sharp peaks after the cryo-treatment in the XRD profile corresponds to the complex carbide phases in the cutting inserts. Finally, a higher peak intensity, a new peak at 77º, and also small, sharp peaks from 73º to 79º with cryo-treated inserts confirmed the hard surface coating over the received conditions of the inserts [40]. This developed new and small sharp peaks with cryo-treated inserts, which enhanced the hardness and resistance to wear over untreated conditions [43 - 46].



(a)



(b)

Figure 6. XRD profiles of the extended region of 70 - 80º of TiN/TiCN/TiN coated cermet inserts: (a) untreated and (b) cryo-treated

3.3 Surface Roughness Value (R_a)

A comparison of the R_a value of the turned alloy grade of 4340 with the as-received and cryo-treated PVD-TiN/TiCN/TiN coated cermet insert is illustrated in Figure 7. The R_a value decreased with a rise in cutting velocity for both kinds of cutting inserts. From the measured R_a value, the cryo-treated coated cermet insert offered a lower R_a value when compared to the R_a value obtained with the untreated condition for all cutting trails. The reason was an increase in mico-hardness [37] and reduced tool wear, which further maintained the cutting ability [47]. In addition, R_a was decreased by 5–29% with a cryogenically treated coated cermet insert over the received condition of coated cermet inserts. The reason was because of the enhanced wear resistance by an increase in hardness with cryogenic treatment. Under these cutting conditions, the surface roughness value was decreased by 27.84%, 28.8%, and 5.17% with cryogenically treated conditions over untreated for 55, 90, and 150 m/min, respectively. From these experiment values, it was revealed that the beneficial impact of cryo-treatment on the finish of the product was decreased with a rise in cutting velocity greater than 90 m/min.

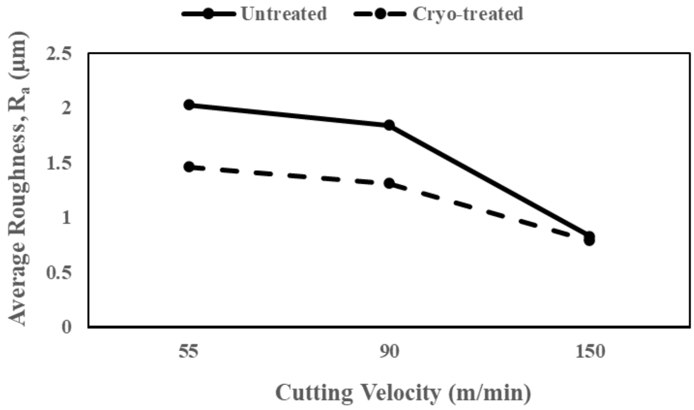
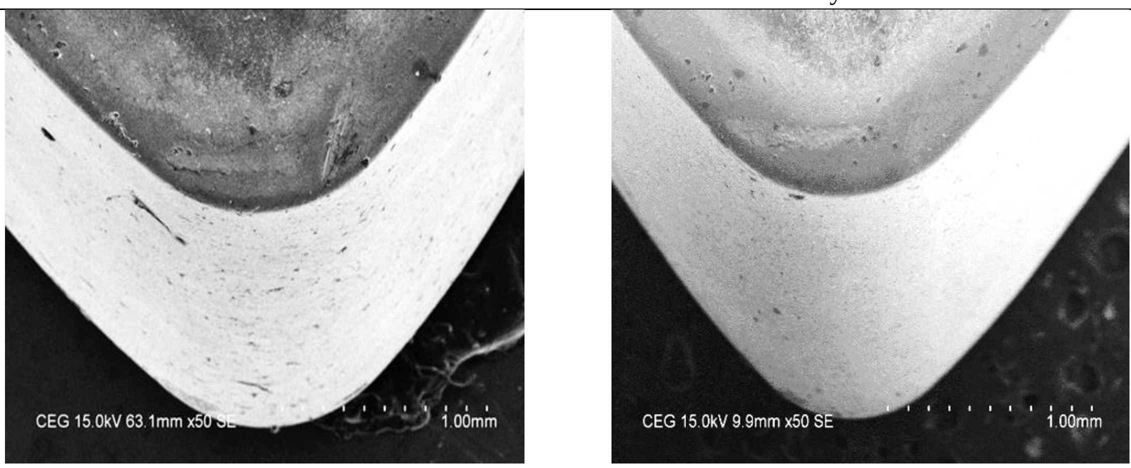


Figure 7. Surface roughness (Ra) value of the turned surface of the alloy grade 4340

3.4 Insert Wear

Figures 8 to 10 show the SEM images of the total cutting edge, rake surface, and primary flank surface of the untreated and cryo-treated coated cermet inserts after dry turning 35 mm of alloy steel grade 4340 at 55, 90, and 150 m/min, respectively. At 55 m/min, a small scratch on the nose extends wider towards the face of the insert adjacent to the primary cutting edge, flaking on the rake surface, and a more adherent chip particle deposition on the face of the cutting inserts was observed in the untreated conditions of coated cermet inserts. However, there was no crack or scratch on the nose as well as the face of the inserts, lower flaking, and adherent chip deposition on the rake surface with the cryogenically treated inserts when compared to the untreated conditions (refer to Figure 8).

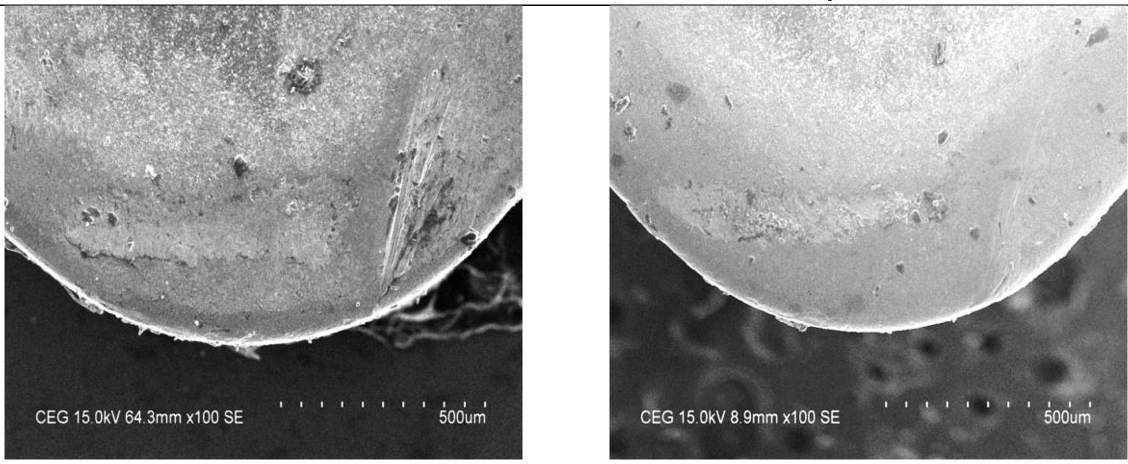
Untreated	Cryo-treated



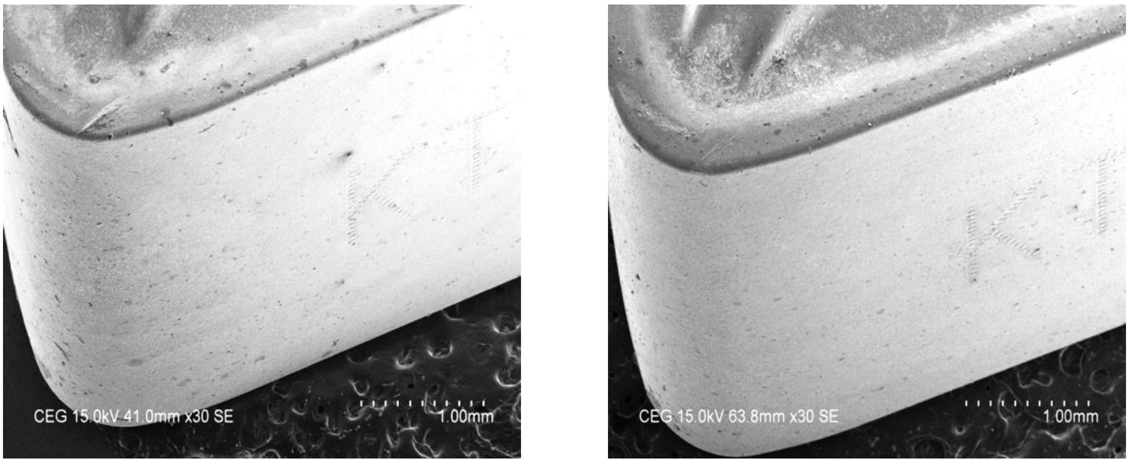
Total cutting edge

Figure 8. SEM view of turned inserts at 55 m/min

Untreated	Cryo-treated



Rake surface



Primary flank surface

Figure 8. (cont.)

At 90 m/min, there was higher flaking on the rake surface nearer to the cutting point, and the primary cutting edge behind the rake surface underwent substantial scratching. There was coating delamination some distance away from the total cutting edge on the face of the inserts, and there was a larger deposition of chip particles on the rake surface with untreated inserts. In addition, lower primary flank wear was observed below the side cutting edge (refer to Figure 9). But, in the case of a cryo-treated insert, instead of flaking, there was coating delamination on the face of the insert near the cutting region. Hence, there was no wear on the primary cutting edge and flank surface and less chip particle deposition on the cutting region.

At 150 m/min, a major scratch and coating delamination occurred on the primary cutting edge along with the face of the insert. A major flaking occurred on the face of the insert at some distance away from the nose that extended towards the auxiliary cutting edge, and substantial wear occurred on the flank surface. Also, more chip particles were deposited on the face of the insert, some distance away from the cutting point. However, in the cryo-treated insert, there was minor flaking occurred on the face of the insert, and coating delamination occurred on the face of the inserts at some distance away from the total cutting edge. In addition, lower flank wear and chip particle deposition occurred on the face of the insert (refer to Figure 10).

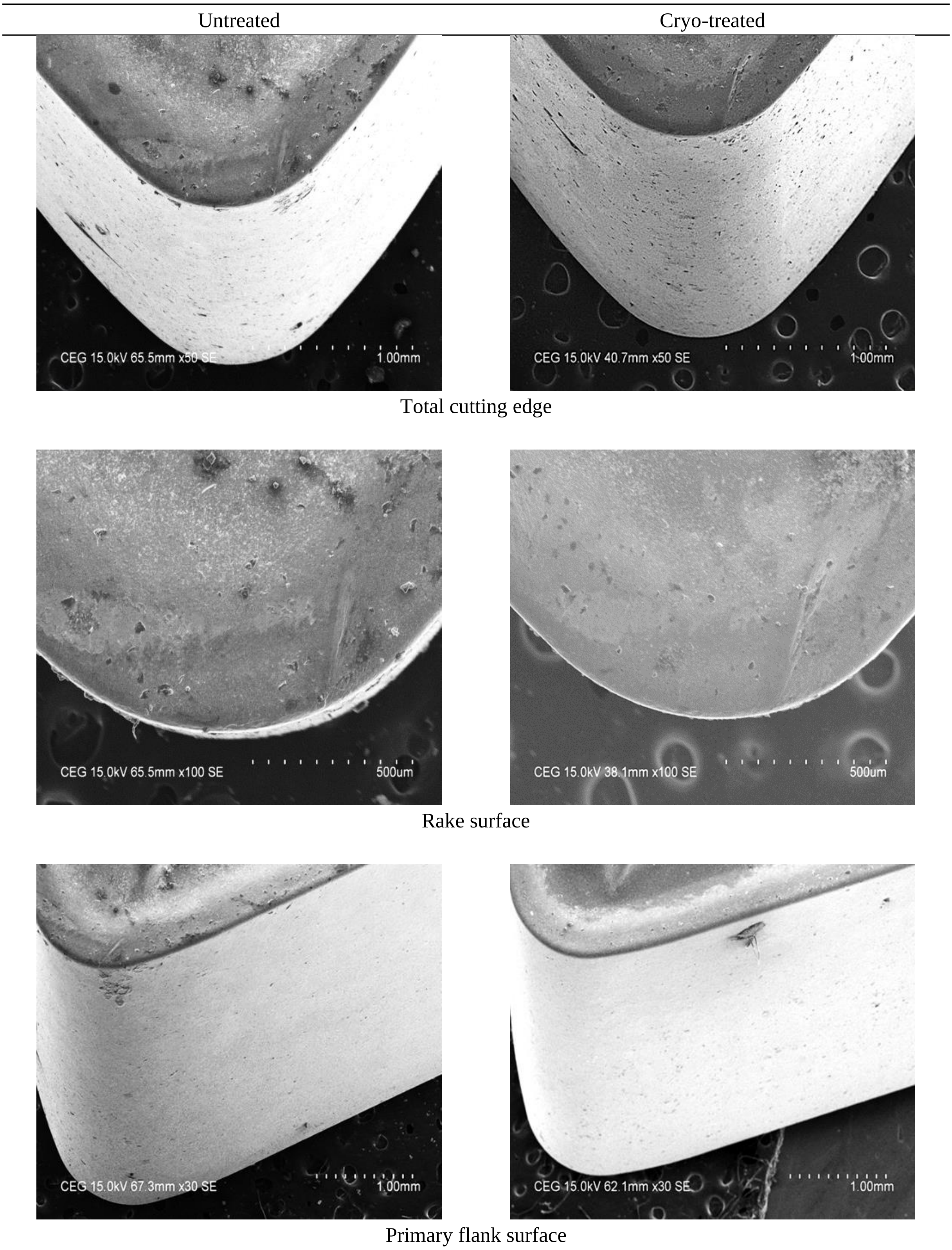
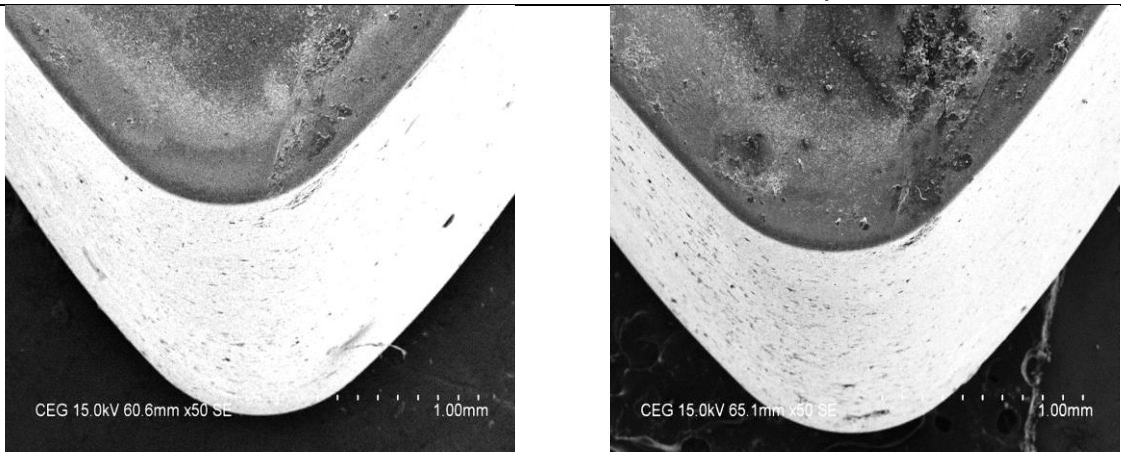
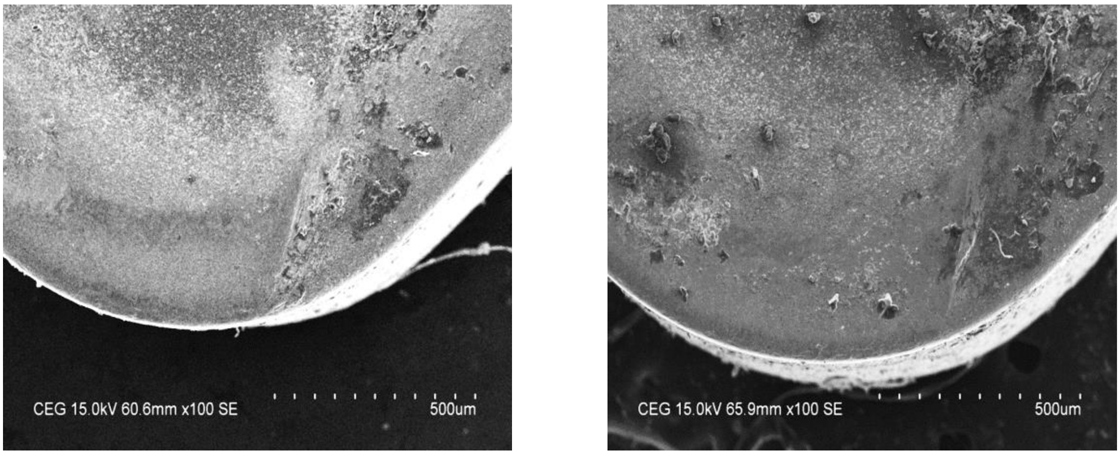


Figure 9. SEM view of turned inserts at 90 m/min

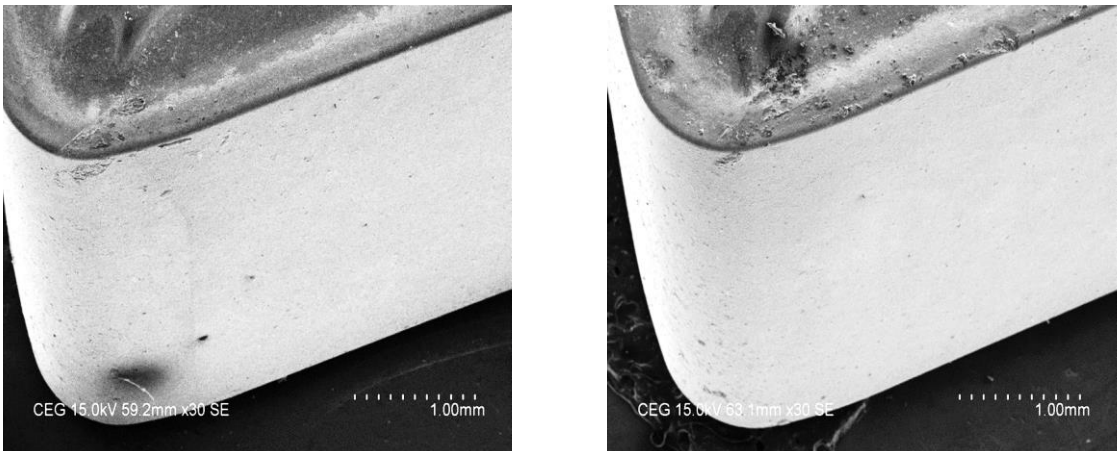
Untreated	Cryo-treated



Total cutting edge



Rake surface



Primary flank surface

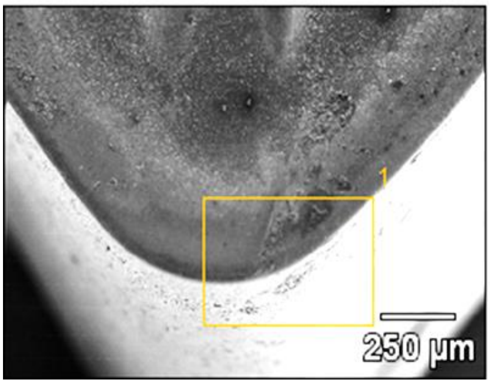
Figure 10. SEM view of turned inserts at 150 m/min

In all the cutting velocity conditions, the major kinds of wear that occurred on the face of inserts were flaking, cracking, scratching, coating delamination, and the adherent of chip particles with untreated conditions. This is due to abrasion and adhesion wear mechanisms. In addition, flank wear was observed with untreated conditions at 90 and 150 m/min. But, in the case of cryogenically treated inserts, minor flaking and scratches, coating delamination, and lower deposition of chip particles occurred on the face of the inserts. In addition, a lower flank wear occurred at 150 m/min. Based on SEM images, it was revealed that similar kinds of tool wear and adherent chip deposition were observed in both cases of coated cermet cutting inserts after 35 mm of turning alloy steel grade 4340. However, a higher level of insert wear and more deposition of chip particles were observed with the untreated cutting tool when compared to cryogenically treated conditions (refer to Figures 8 to 10). This was due to enhanced wear resistance with the cryogenic treatment, which reduced the rate of tool wear during the cutting operation [44–46, 48, 49].

3.5 EDS Analysis of Turned Inserts

To know the wear mechanisms at the cutting point, an EDS analysis of turned inserts was carried out to identify the deposition of work material constituents. The basic elements in the TiN/TiCN/TiN-coated cermet inserts are 5.72% C, 19.45% N, 8.74% O, 0.61% Na, and 65.47% Ti. Hence, the basic elements of AISI 4340 steelwork material are 0.28% Si, 1.75% Ni, 0.9% Cr, 0.69% Mn, 0.3% Mo, 0.38% C, and 95.75% Fe.

The EDS investigation of the untreated condition of TiN/TiCN/TiN-coated cermet inserts after turning 4340 alloy steel at 150 m/min is illustrated in Figure 11. The basic elements of AISI 4340 alloy steel, such as 16.69% Fe, 0.33% Cr, and 0.28% Si, were found in the untreated tool. A significant reduction in coating elements with untreated conditions was due to the deposition of basic elements of AISI 4340 alloy steel, which reduced the revelation of coating elements. In addition, the reduction in coating elements, such as Ti from 65.47% to 45.84% and N from 19.45% to 13.10%, was found in the untreated condition of the inserts over the fresh inserts.



Element	Wt. (%)
C	8.54
N	13.1
O	14.31
Na	0.36
Ti	45.84
Al	0.54
Si	0.28
Cr	0.33
Fe	16.69
Total	**100**

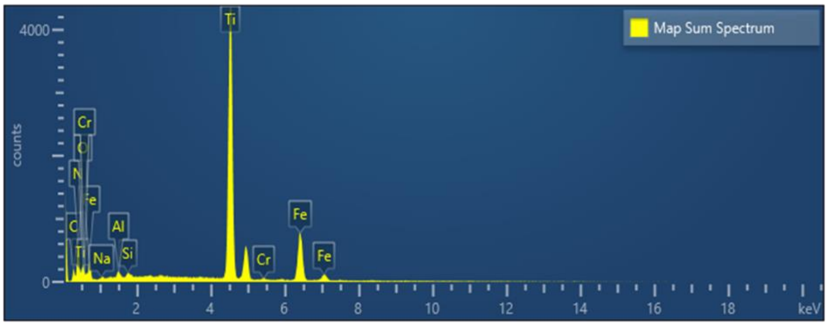
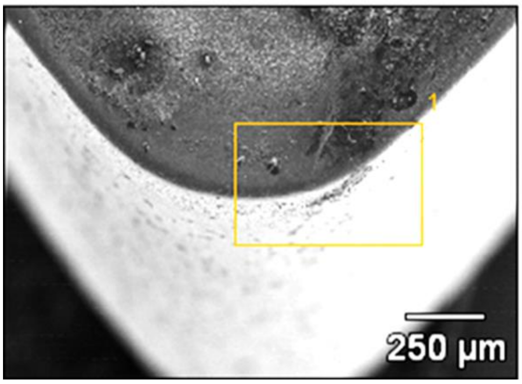


Figure 11. EDX analysis of the untreated condition of turned inserts



Element	Wt. (%)
C	8.48
N	15.99
O	15.88
Na	0.42
Ti	48.98
Al	0.33
Si	0.23
Fe	9.69
Total	**100**

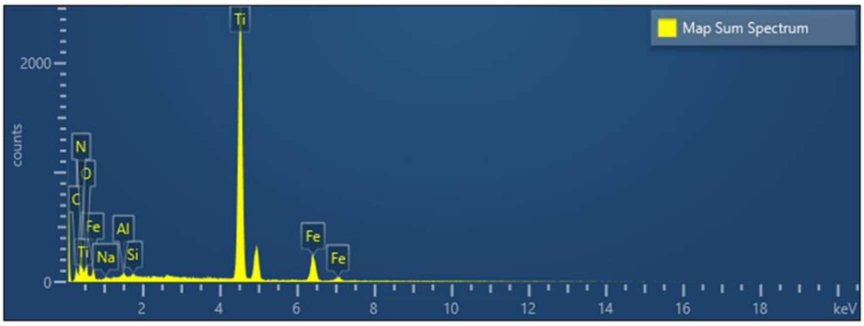


Figure 12. EDX analysis of the cryo-treated condition of turned inserts

Figure 12 shows an EDS investigation of the cryo-treated inserts after turning 4340 alloy steel at 150 m/min. It was observed that the basic elements of alloy steel 4340, such as 9.69% Fe and 0.23% Si, were present on cryo-treated inserts. In addition, the reduction in coating elements, such as Ti from 65.47% to 48.98% and N from 19.45% to 15.99%, was found in the cryo-treated condition of the inserts over the fresh inserts. The deposition of elemental work material was common in untreated and cryo-treated conditions (refer to Figures 11 and 12) due to abrasion and adhesion wear mechanisms, but the amount of deposition was lower with the cryo-treated inserts. Hence, the loss of coating materials, such as Ti and N, was lower with the cryo-treated inserts when compared to the untreated ones. This was due to the enhanced hardness and resistance to wear of the cryo-treated condition of the tool.

4.0 CONCLUSIONS

The following conclusions were observed during the cryo-treatment of cermet inserts and the dry cutting performance of alloy steel grade 4340 with as-received and cryogenically treated coated cermet cutting inserts.

- Microhardness was increased by 0.7% with the cryogenically treated condition when compared to the as-received condition.
- A small, sharp peak was observed from 73º to 79º for cryogenically treated inserts over untreated ones through XRD profiles.
- The R_a value of turned AISI 4340 alloy steel was reduced by 5–29% with cryogenically treated coated cermet inserts over others.
- Lower tool wear and adhesion of chip particles on the cutting point occurred with cryogenically treated inserts over untreated ones.

The study results indicated that the resistance to wear of cutting tools was enhanced with cryo-treatment and thereby provided beneficial effects on the finish of the product and the wear of inserts when the alloy steel grade of 4340 was turned over the received condition of the cutting inserts.

5.0 ACKNOWLEDGMENT

The author has been supported by Sri Sivasubramaniya Nadar College of Engineering, Kalavakkam – 603110, Chennai, through the Internally Funded Projects.

6.0 CONFLICT OF INTEREST

The author reports no declarations of conflict of interest.

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