Determination of CVD Coating Thickness for Shaped Surface Tool

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***Abstract* – Nowadays it is very important to reach optimal life time for tools used in industry. CVD coatings belong together with the PVD coatings to the most commonly used final surface treatment. Determination coating properties, such as tribological properties, hardness, thickness and many others are very crucial. Presented research is focused on determination of individual layer thickness in multi-layer CVD coating used for surface treatment of shaped surface tools.**

***Keywords* – calottes, CVD, coating, tool**

1. Introduction

In terms of practical application, the choice of tool coating thickness is one of the most important characteristics. This can ultimately affect the durability of the tool, as well as friction forces, cutting forces, and so on, (by tool type) while using the tool. Simply put - the thickness of the coating must actually be "tailor-made" to the intended use of the tool.

The thickness of the layer at the edge of the tool differs significantly from the thickness of the layer on straight or cylindrical surfaces. At the same time it is influenced by the diameter of the tool and the method of loading the coating chamber.

DOI: 10.18421/TEM72-26
https://dx.doi.org/10.18421/TEM72-26

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Received: 21 March 2018.
Accepted: 03 May 2018.
Published: 25 May 2018.

Shaped surface tools (Fig. 1.) are characterized by the need for high-quality coatings. Such tools are economically very costly to produce. For this reason, it is necessary to test the coatings on the test bodies and then apply coatings to these instruments [1].

Fig. 1. Shaped surface tool

Currently there is no accurate, simple and non-destructive method for evaluation. For the measurement of planar parts of tools is used the calotester (Fig. 2.) [2],[10],[12],[13].

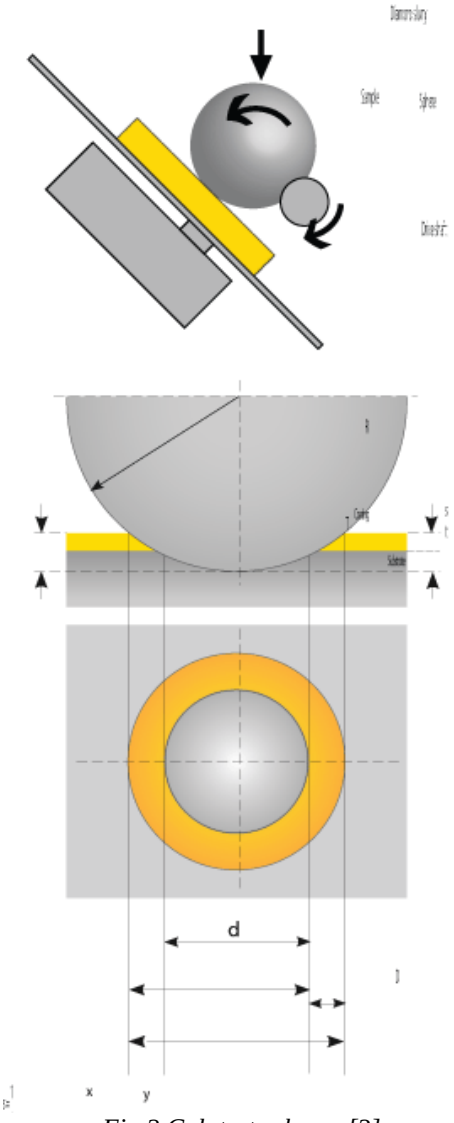

Fig.2 Calotest scheme [3]

After measuring the parameters of the imprint (Fig. 3.) and subtracting them in the optical device, the thickness of the applied layer is calculated by fitting it into (1) :

$$a = \sqrt{R^2 - r_1^2} - \sqrt{R^2 - r_2^2} = \frac{xy}{2R} \quad (1)$$

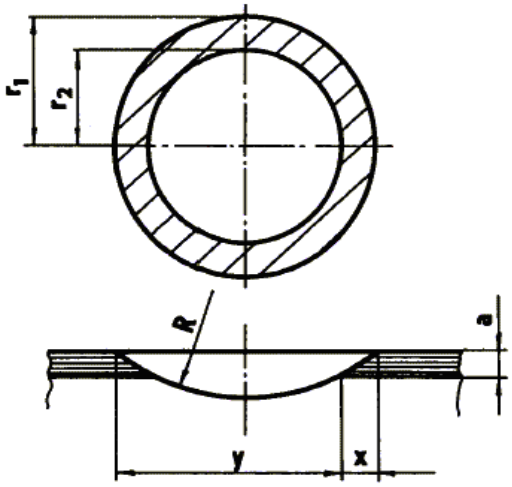

Fig .3 Measured parameters of imprint in deposited layer after calotest [2]

The principle of measurement is simple. From the diameter of the ball and the microscope of the measured spherical canes, the thickness of the deposited layer can be determined by calculation. For better accuracy, this measurement should be performed on polished standards [4],[8],[10].

2. Experimental testing

When measuring the thickness of the TiCN coating, we used the above method of calotest, where a rotating steel ball with a diamond paste affects the deposited layer and part of the surface of the substrate. In the case of layer measurement by this method, it is necessary to determine the measurement parameters, namely the size (diameter) of the steel ball, the speed of the carrier, the duration of the test and the size of the diamond paste grain [5],[7] [11].

Fig.4 Calotest device form manufacturer CSM

In our case was used the calotester from CSM (Fig. 4.) with a 3cm diameter ball, a diamond paste with a grain size of 1 μm, and the device parameters were: 800 rpm and the test time was set to 2 times 900 s.

A sample of the same dimensions as the scratch test was used for the test. The coated specimen was mechanically clamped into the beater which was tilted at an angle of 35 ° - 40 ° upon setting the bead

blade (larger balls require a smaller angle). In the next step, the aforementioned device parameters were set and after the engine was started, a diamond paste was applied to the ball [6],[2],[9].

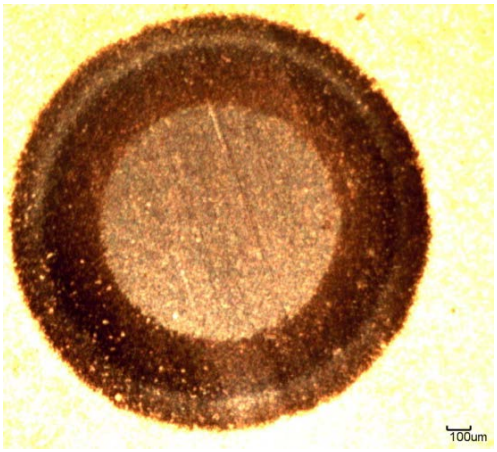

Fig.5 Imprint from calotest on CVD layer

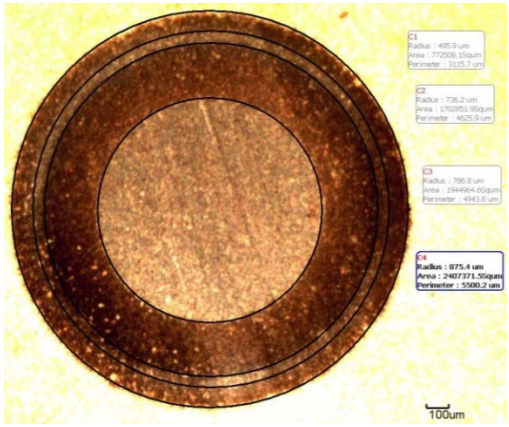

Fig.6 Circle diameters for calculation of layers thicknes

At the end of the test, the specimen with a fingerprint was observed under the macroscope (Fig. 5.)) and using the evaluation program the measured circle size to calculate the thicknesses of the individual layers. Circular diameters are marked from C1 through C4: C1 - 992 µm, C2 - 1472 µm, C3 - 1574 µm, C4 - 1750 µm (Fig. 6.)). The thickness results of the individual layers are shown in Table 1. and were calculated after fitting into the relationship (1).

Tab.1 Thicknes of layers of TiCN coating

Layer	Layer thickness (µm)
TiC	9,86
TiCN	2,59
TiN	4,89
Thickness CVD coating	17,34

To verify the overall thickness of the layer, the specimen with imprint test was subjected to a 3D optical confocal microscope (Figure 7.), where we measured the total thickness of the coating.

Following figure (Fig. 7.) shows the thickness of the TiCN coating at a total value of 17.37 µm. In the center part of the imprint (Fig. 8.) it is possible to see the coating breaking up to the substrate.

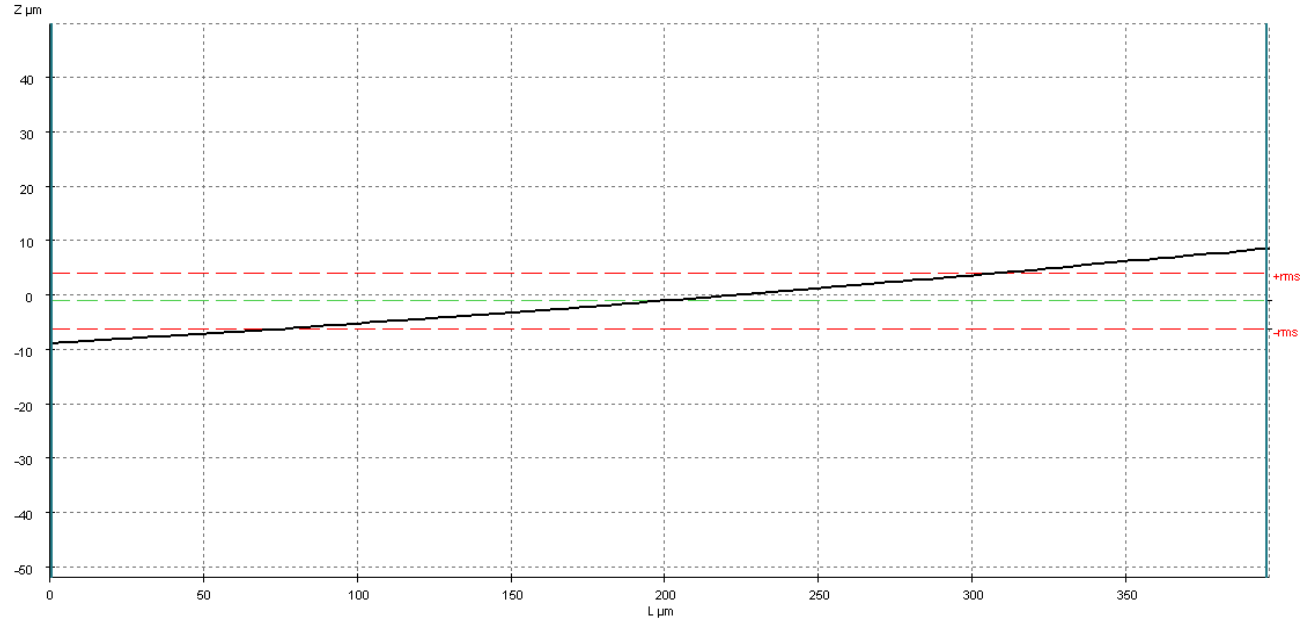

Fig.7. Thicknes of TiCN layer measured using 3D confocal microsco

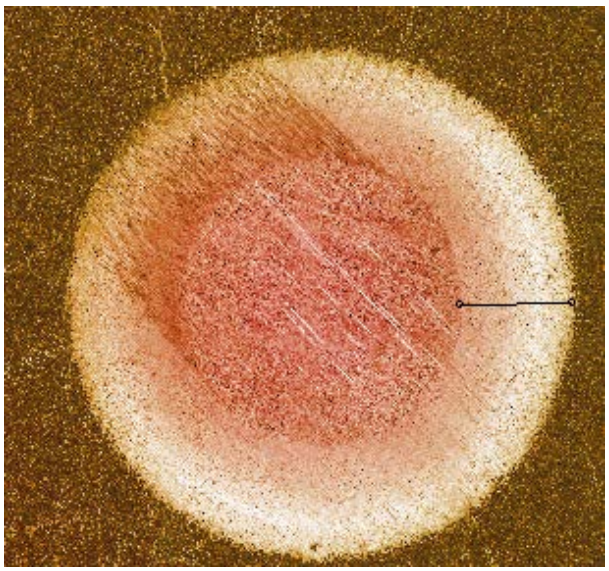

Fig.8 Imprint image of calotest with marked place for TiCN coating thicknes measurement

Thickness values obtained using 3D confocal microscope reaches the same values but the measurement of the individual layers of the coating is only possible by calculation (Table 1.).

3. Conclusion

TiCN coating thickness measurement using calotest and 3D confocal optical microscope was detected, and the total thickness reached 17,36 μm. By means of circles for calotest examination and subsequently by calculation, were determined the thicknesses of individual layers: TiN layer – 4,89 μm ,TiCN layer 2,59 μm and TiC 9,86 μm.

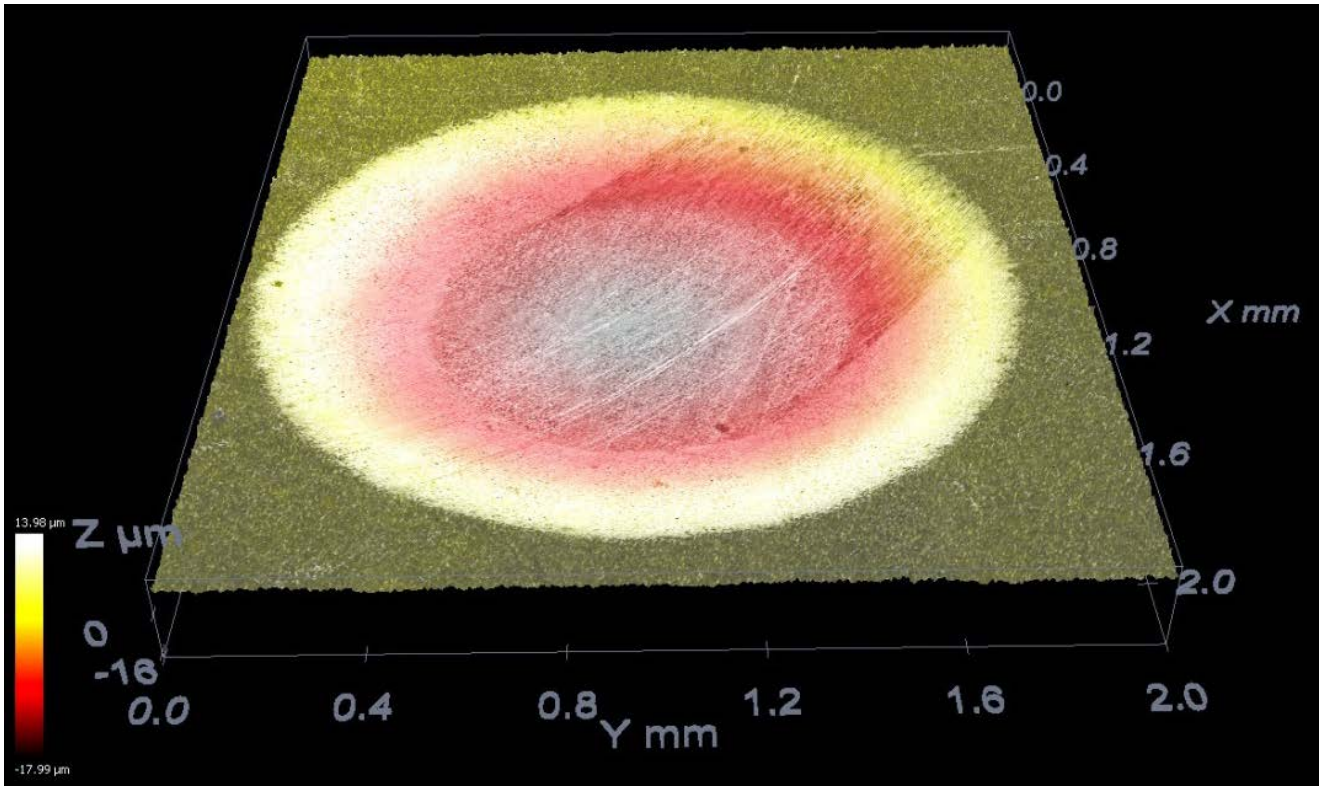

Fig.9 3D image of imprint

Figure 9. shows 3D image of calotest imprint on measured sample. Determination of the total thickness of the TiCN coating, either by calculation (1) or by measuring using a 3D optical confocal.

Acknowledgements

This paper has been elaborated in the framework of the project of the project VEGA 1/0682/17 Research, Development and Experimental Verification of Tool Prototype for Forming Rifled Tubes and in cooperation FVT TUKE based in PO and R&D Centre s.r.o. under contract no.01/2014.

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