The influence of corundum particles as filler on properties of hard chromium coatings

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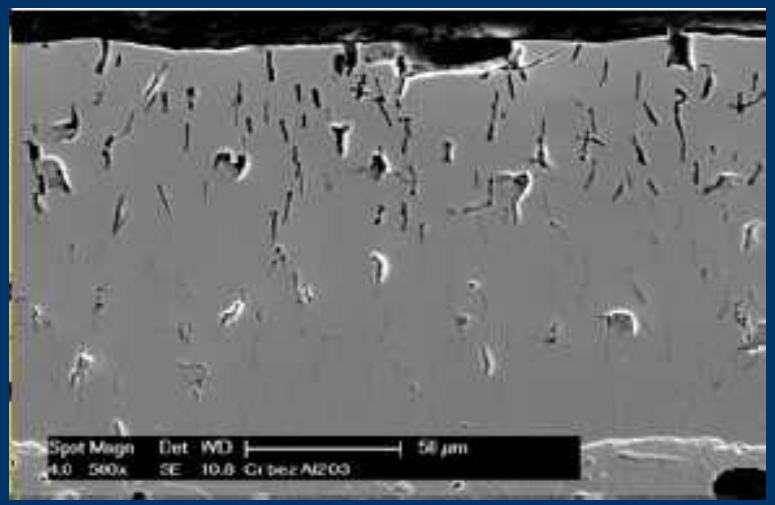
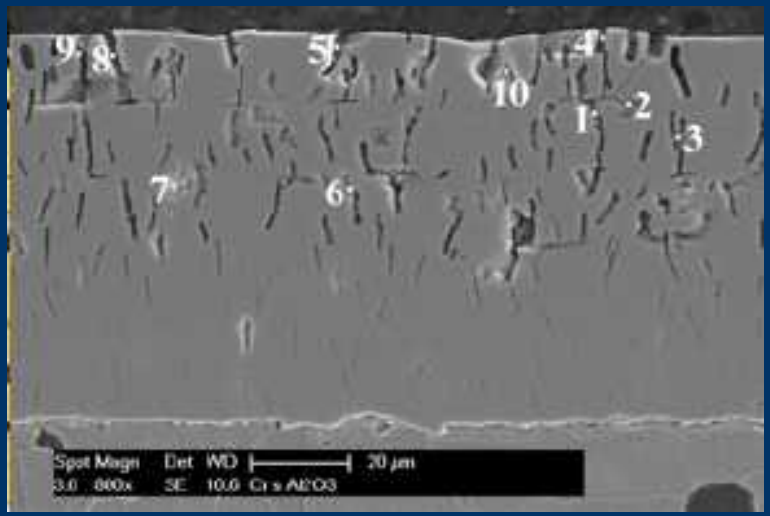
Objective

Compare the properties of Cr coating without Al_2O_3 and with Al_2O_3 and determine the effect of Al_2O_3 as a filler on the mechanical properties of coatings

Galvanic hard chromium coatings

- Hard chromium
- Porous chromium
- Porous chromium with Al_2O_3 filler

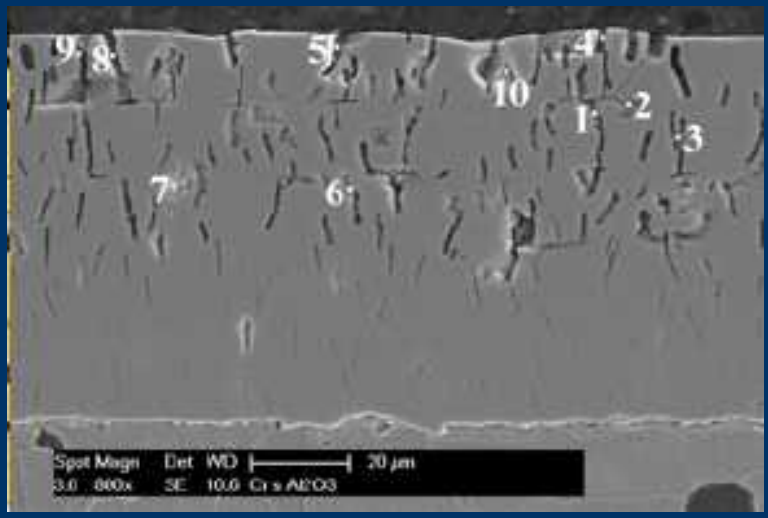


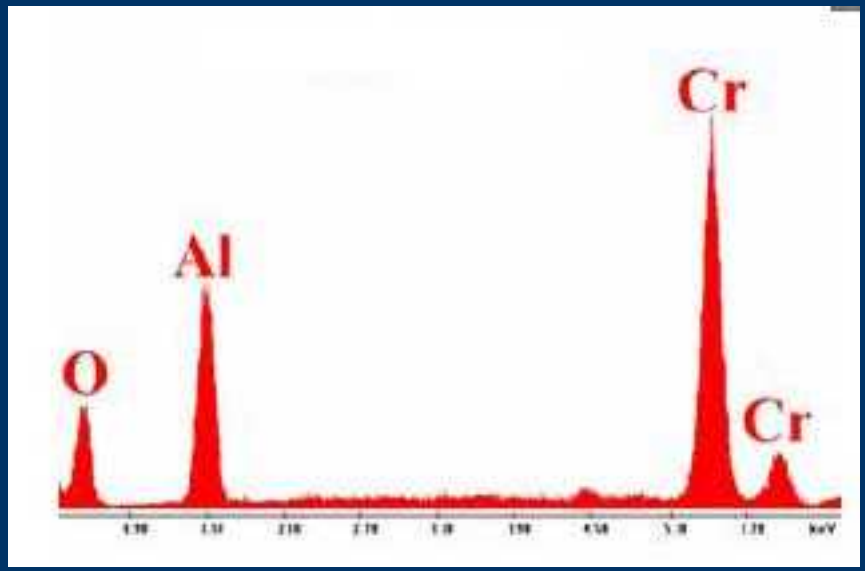


Cromium coating with Al_2O_3

point	O	Al
1	17.3	24.8
2	13.3	17.9
3	13.1	18.1
4	21.4	28.2
5	17.4	26.8
6	16.5	24.6
7	16.8	23.3
8	20.3	25.4
9	20.0	25.4
10	12.1	18.4

Values of spot analysis done by EDX





Experiment

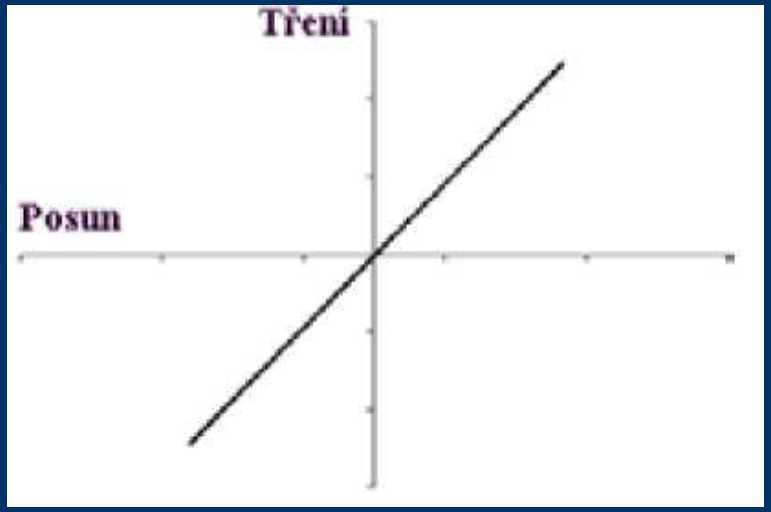
Fretting test

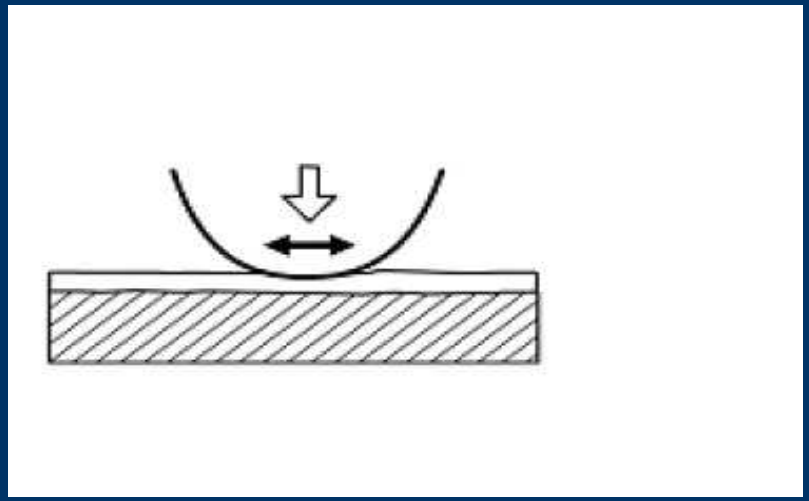
Wear of surface that can occur in applications where the contact is affected by mechanical vibrations.

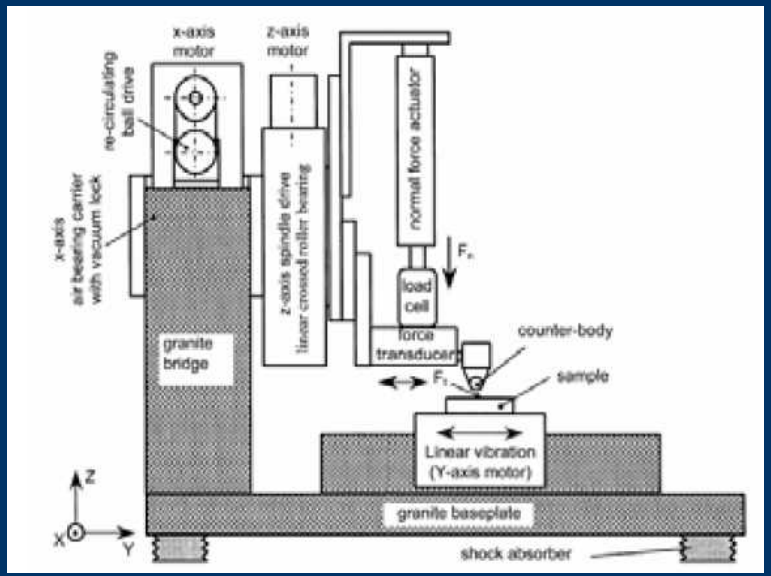
Impact test

The test is based on cyclic impacts of a testing body with a defined force on the surface of material.

Fretting test principle







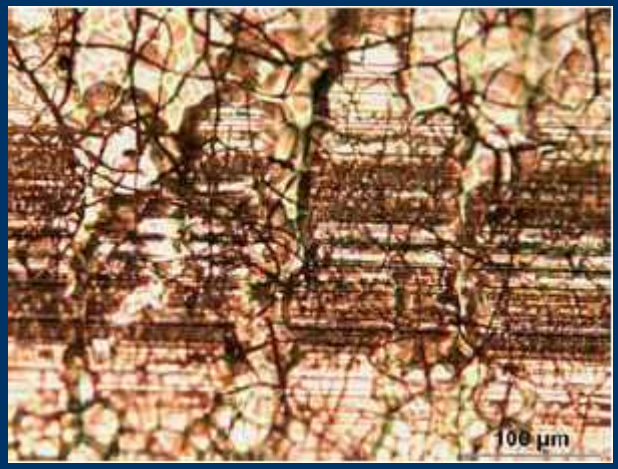
Fretting test parameters

- 5000 and 10000 cycles - WC (sintered tungsten carbide) “PIN”
- 1000 cycles to obtain coeficient of friction – steel “PIN”

Coating	Cycles	Load [N]	„PIN“ materiall	Track width [µm]
Chromium vith Al2O3	5000	5	WC	238
	10000	5	WC	286
Chromium without Al2O3	5000	5	WC	300
	10000	5	WC	309

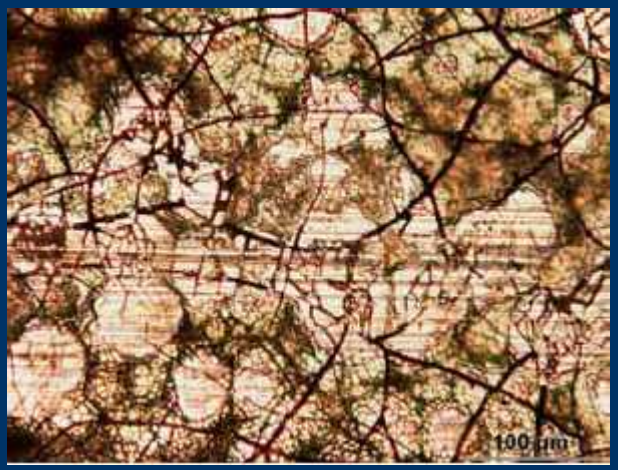
Fretting test

Fretting test track
5,000 cycles Al2O3



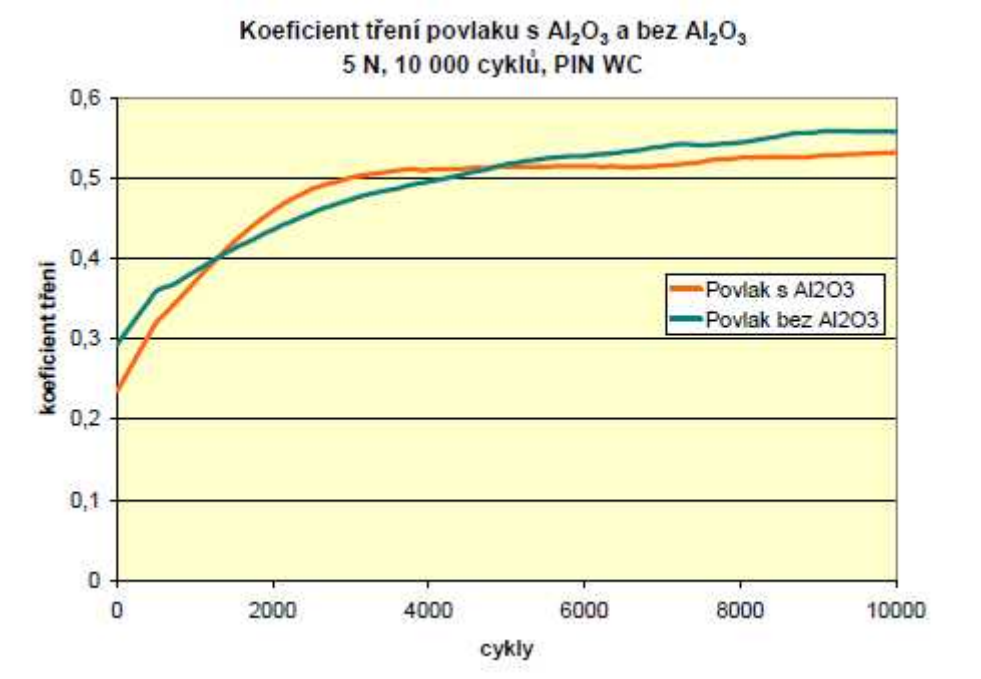
Fretting test track
10,000 cycles Al2O3

Fretting test track – 5,000 cycles

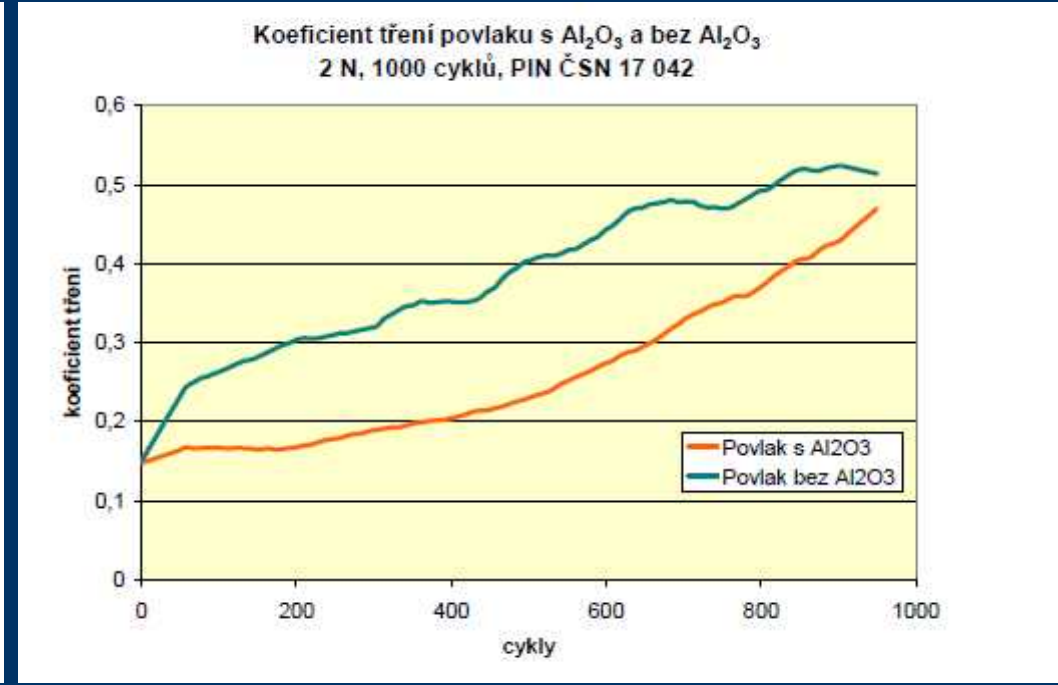


Fretting test track – 10,000 cycles

Coefficient of friction



Coefficient of friction 10,000 cycles



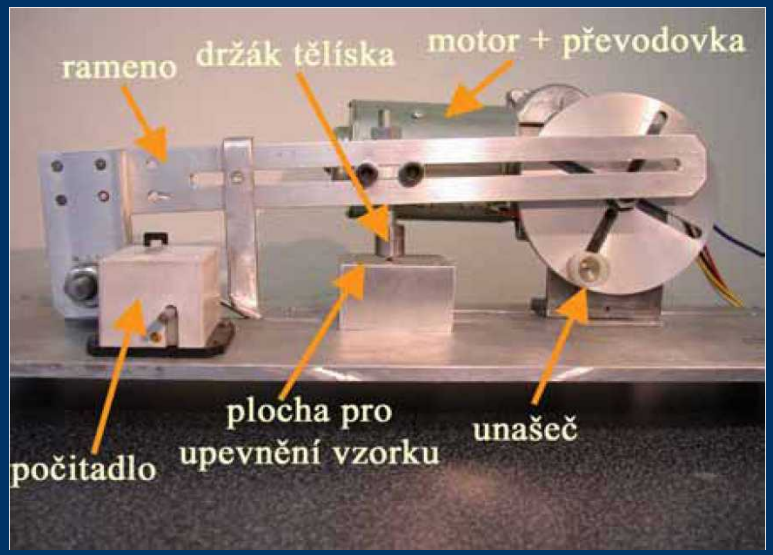
Coefficient of friction 1,000 cycles

Fretting test conclusion

- Al_2O_3 shows bigger wear resistance
- Lifting of coating does not occur in any test
- After 10,000 cycles the wear track is covered by wear debris
- The increase of wear between 5,000 and 10,000 cycles is more pronounced for the coating with Al2O3
- Coefficient of friction of both coatings has approximately the same trend when PIN made of wolfram carbide is used
- Coating with Al2O3 has a higher coefficient of friction when steel pin is used

Impact test

The test is based on cyclic impacts of a testing body with a defined force on the surface of material. The purpose of the test was to identify resistance of chromium layers to shock contact stress and determine the influence of Al_2O_3 filler

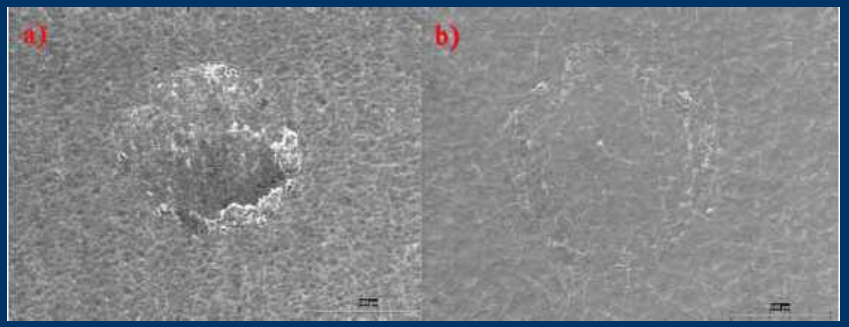


Impact test paramaters

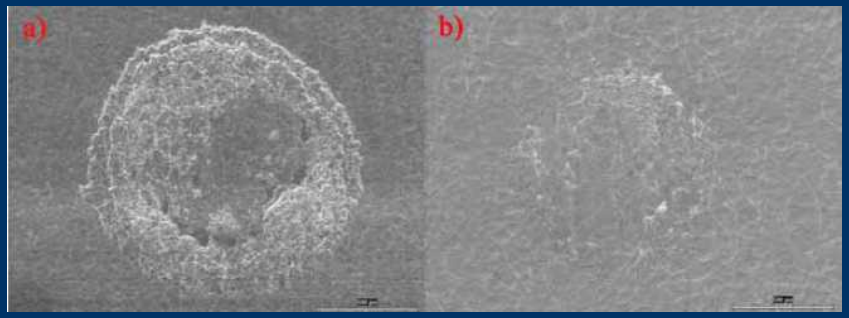
- Impact energy E=25J
- tungsten carbide impact ball
- Tests were performed with 100, 2500 and 5000 impacts
- Impact craters were evaluated by light confocal and electron microscopy
- Pattern character has been studied at impact point
- Depth of crater has been measured without contact using a laser confocal microscope Olympus LEXT

Impact test - results

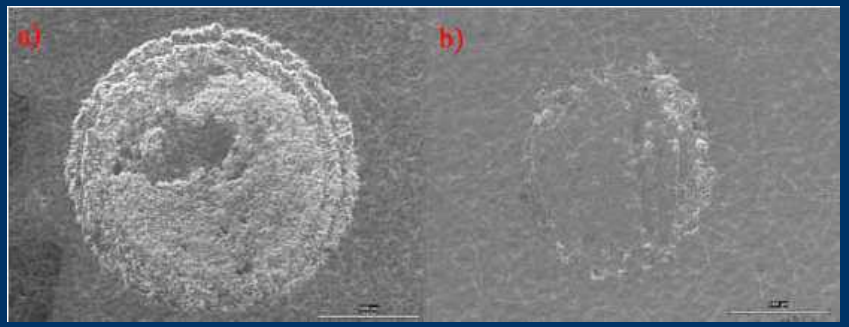
1,000 impacts



2,500 impacts



5,000 impacts



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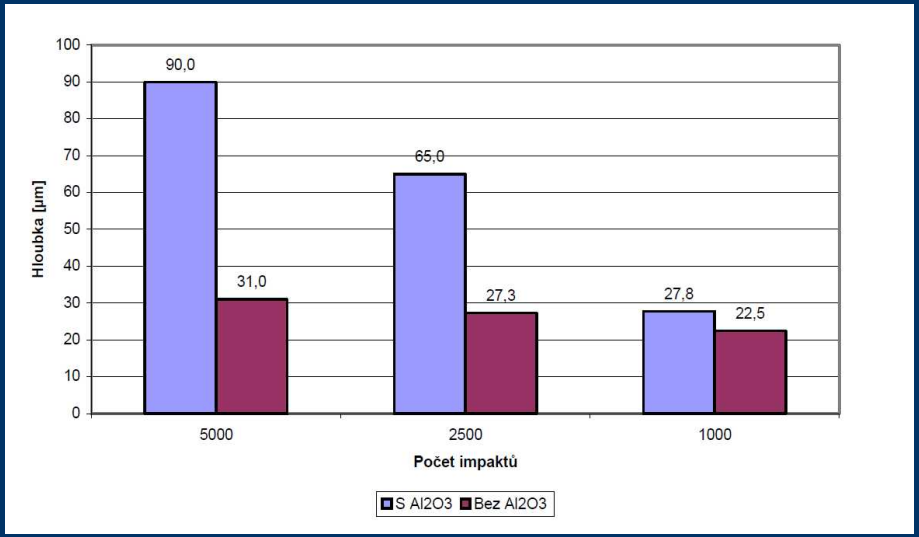
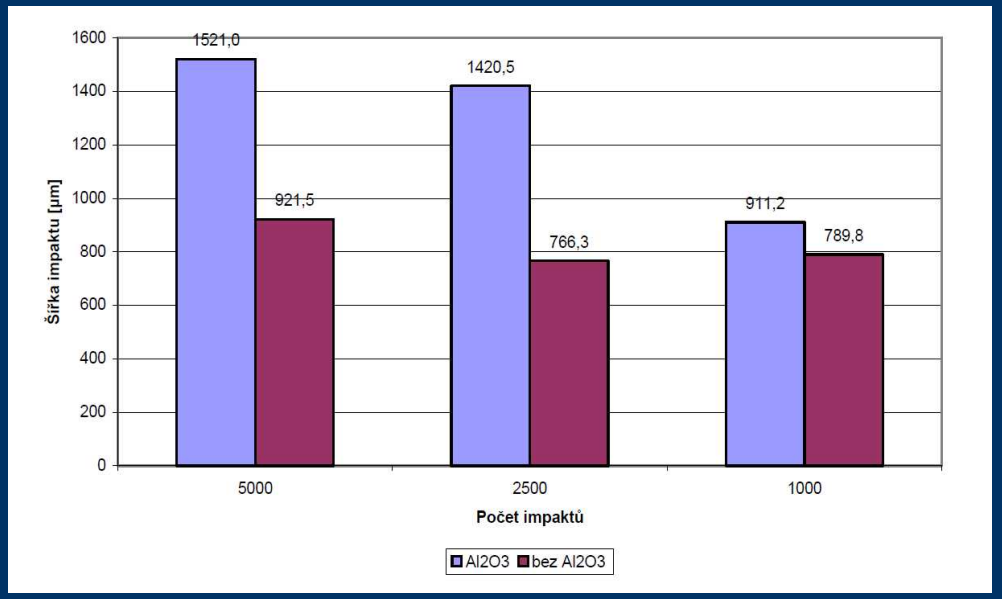
Depth and witdh of impact craters



Depth of impact craters



Width of impact craters

Impact test conclusion

- The results illustrate that the microcracks affect the resistance to dynamic shock loads
- This is due to the ability of pores to eliminate the effects of accumulated tensile stresses
- Al_2O_3 particles contained in the coating matrix can affect coatings consistency
- Coating without Al_2O_3 resists shock contact wear better than coating with filler
- Visual control for industrial use

Thank you for your attention

This study can be published on the basis of solving student project KMM – ZČU Plzeň