



# Metals and Grinders A Technology Update

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*(presented to the FRW club May 2017)*



Changes in tool steel and grinding wheel technologies are changing our choices of woodturning tools and grinding wheels



## Purpose:

- To discuss recent developments in modern tool steels and high speed steels (HSS)
- To discuss recent developments in grinding wheel technologies
- To discuss implications for modern woodturners
- Grind various steels on various grinders and examine the grinds under 300X microscope
- Analyze the results, draw conclusions



Please ask questions



There have been recent significant changes in both tool steels and grinding wheels.

Many woodturners have been confused by these changes.



## Evolution of tools

- First tools were wood, bone, antler
- Stone tools, Stone Age
- Bronze (copper and tin), Bronze Age
- Iron, Iron Age
- Steel (iron with carbon)
- High-carbon steel (iron with more carbon to make it harder)
- High speed steel (molybdenum, chromium, tungsten, vanadium, cobalt, etc.). M2 is excellent HSS



Let's examine the  
current  
state of the art.



# M2 is by far the most widely used high speed steel for modern woodturning tools

Henry Taylor, Hamlet, Robert Sorby, Ashley Iles, etc.





# Evolution of Particle Metals:

M4

M42

2030

2060

CPM10V (A11)

CPM15V

Etc.



CPM 10V is emerging  
as the most widely  
used of the new  
particle metals

Vicmarc, Thompson, SB Tools, Glaser, etc.



# Composition of M2 and CPM10V

M2 is the most widely used conventional High Speed Steel for wood-lathe cutters. CPM10V is one of many Particle Metal Steels used in modern wood-lathe cutters. Definitions agreed by American Iron and Steel Institute (AISI).

	M2	CPM10V
Carbon	0.95	2.45
Vanadium	2.00	9.75
Chromium	4.00	5.25
Manganese		0.50
Molybdenum	5.00	1.30
Tungsten	6.00	
Silicon		0.90
Sulfur		0.07
Iron	82.05	79.78



## Let's add more!!

If a little bit of additives like molybdenum, chromium, tungsten, vanadium and cobalt makes steel better and more heat resistant, why not add more??

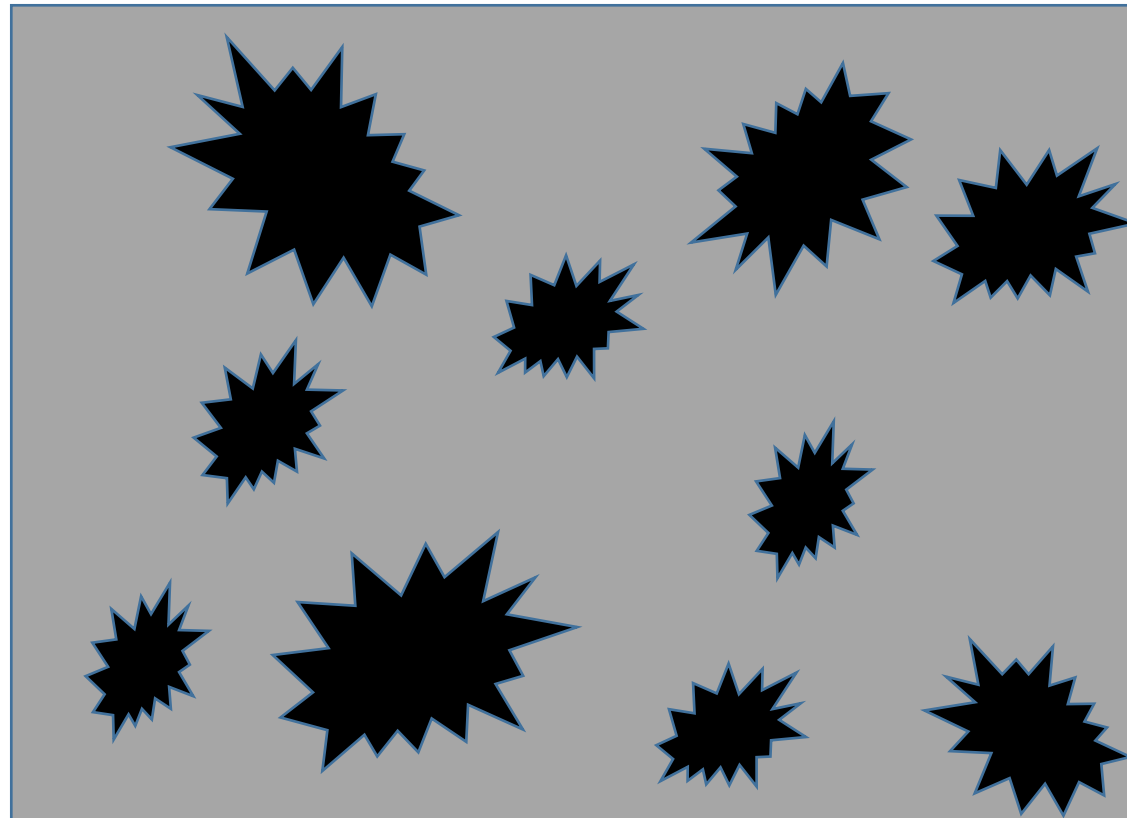


## Problem!

Too high a percentage of additives (vanadium, tungsten chromium, molybdenum, etc.) caused the additives to clump together as the molten metal cools, creating very hard inclusions, called carbides.

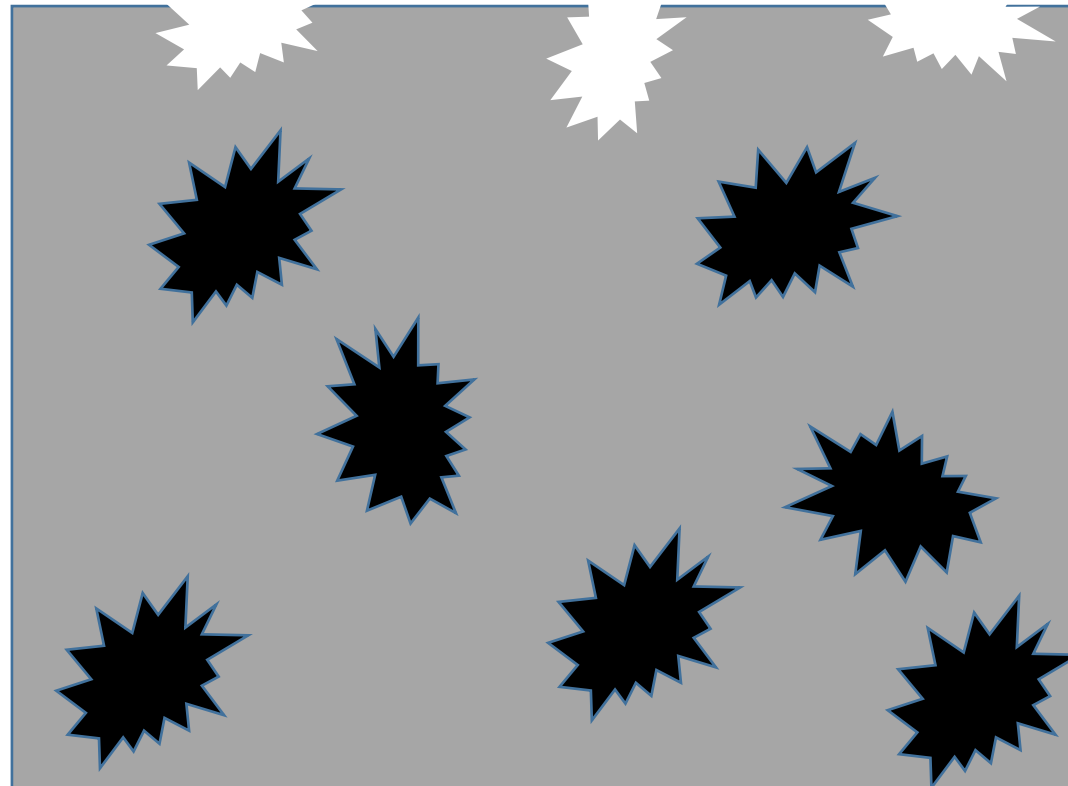


Some of the alloys clump together forming carbides



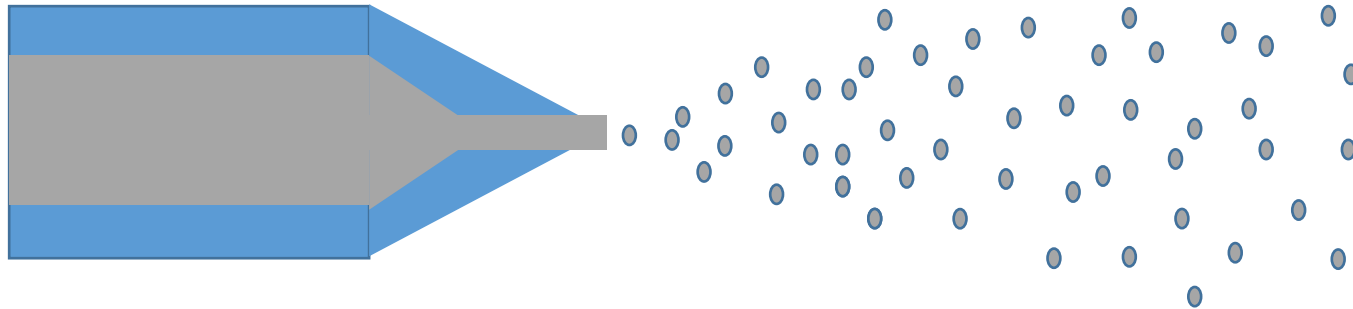


# Particle metal steel ground on conventional cast wheel





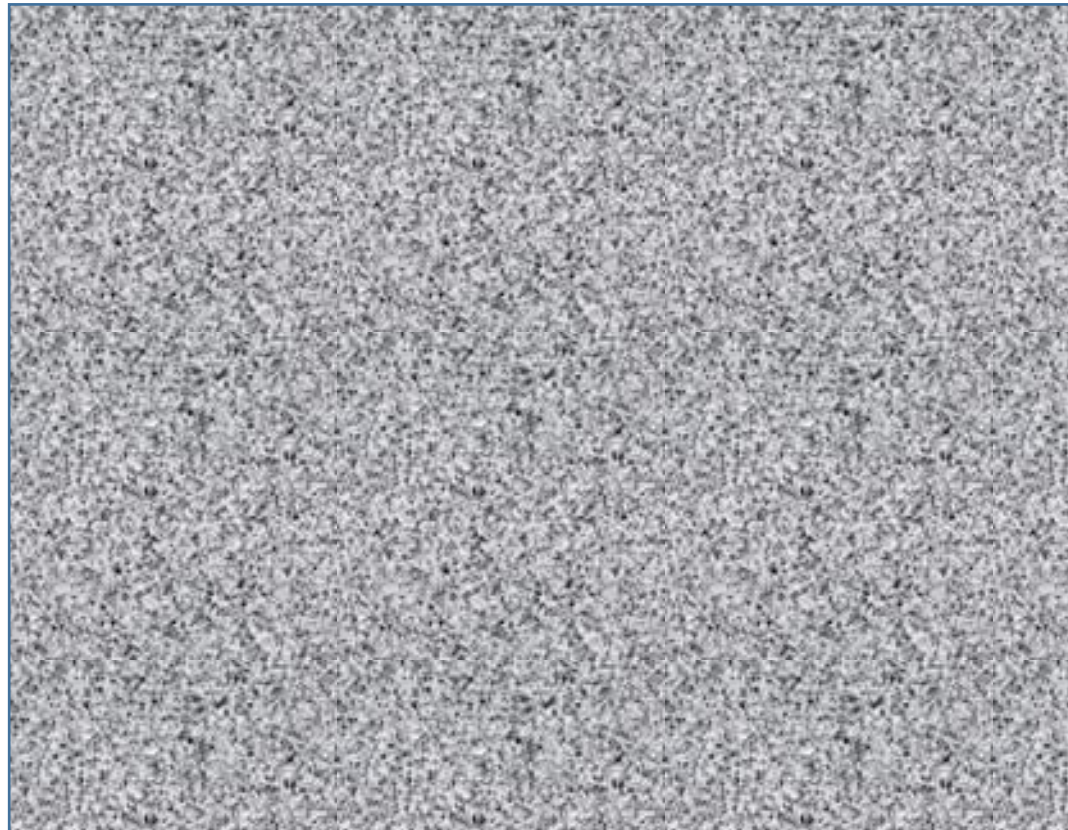
Molten steel forced at high pressure through a nozzle to form millions of microscopic droplets containing even smaller carbides





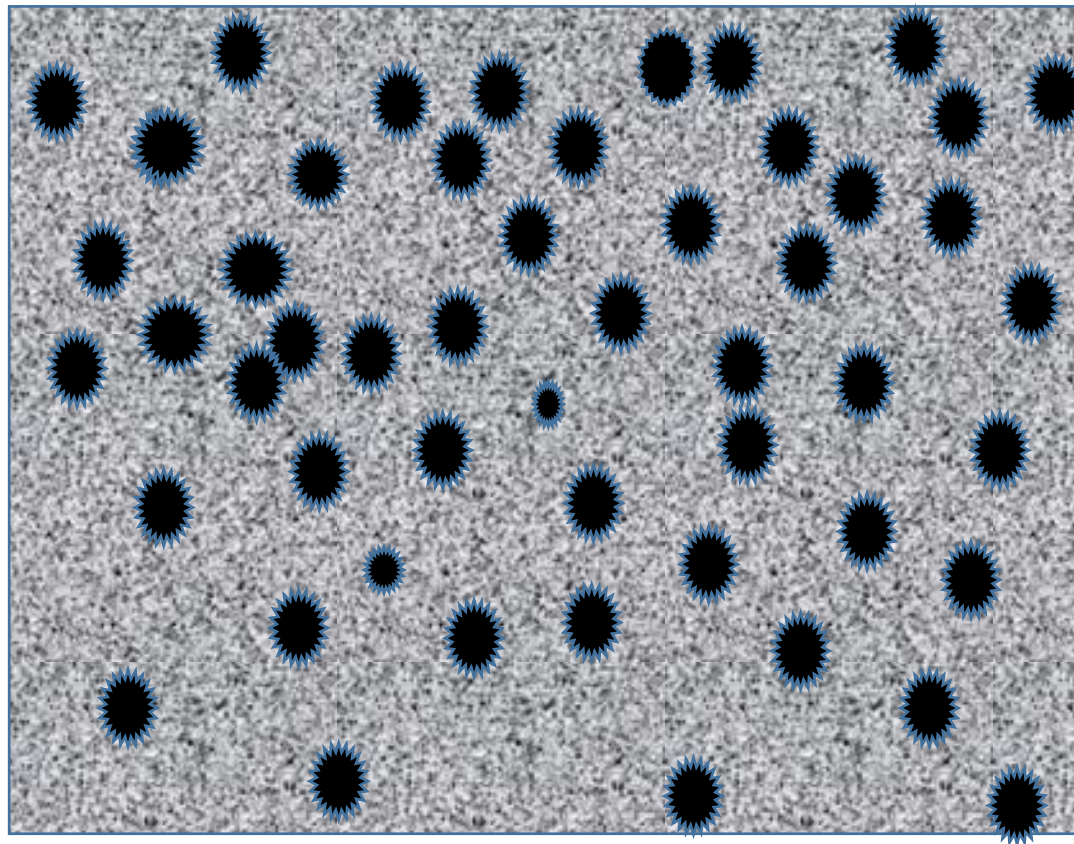


The particles are then compressed into a solid ingot through the Hot Isostatic Pressure (HIP) process



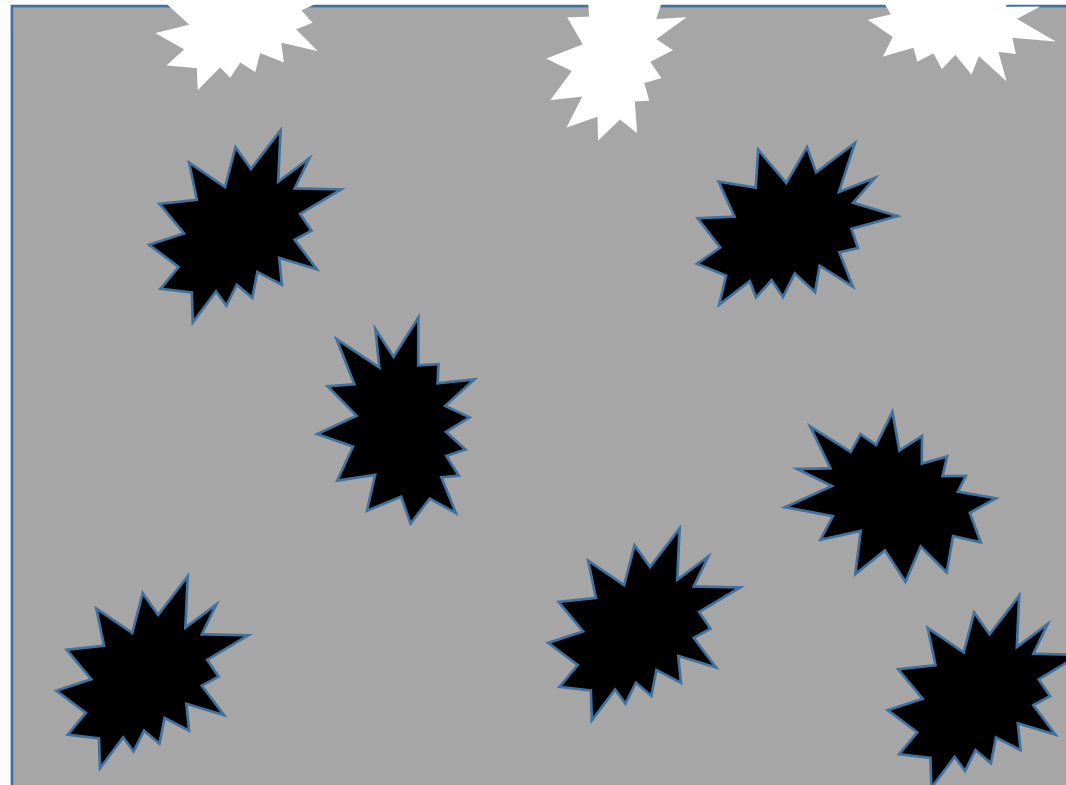


# Conventional grinding wheel with abrasive imbedded in matrix





# Particle metal steel ground on conventional cast wheel



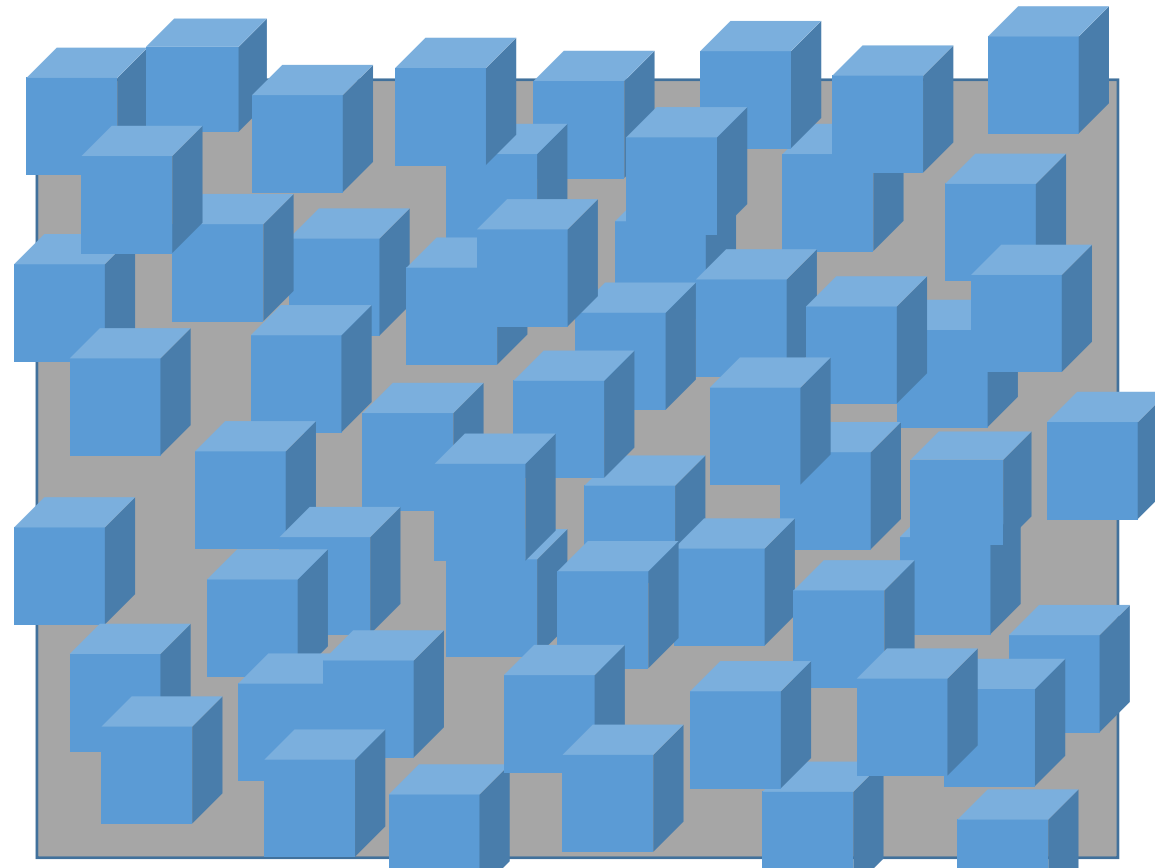


# Cutting edge of Particle Metal tool Ground on conventional wheel



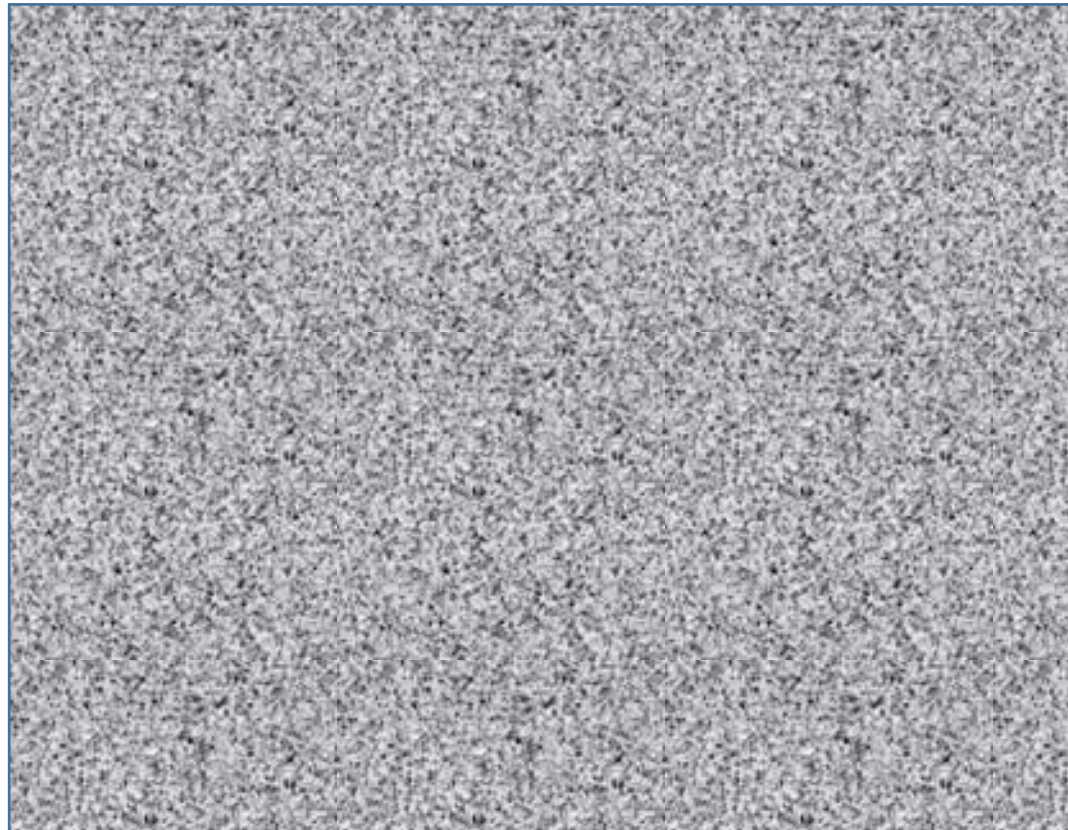


# Cubic Boron Nitride (CBN) grinding wheel with CBN abrasive bonded to steel wheel

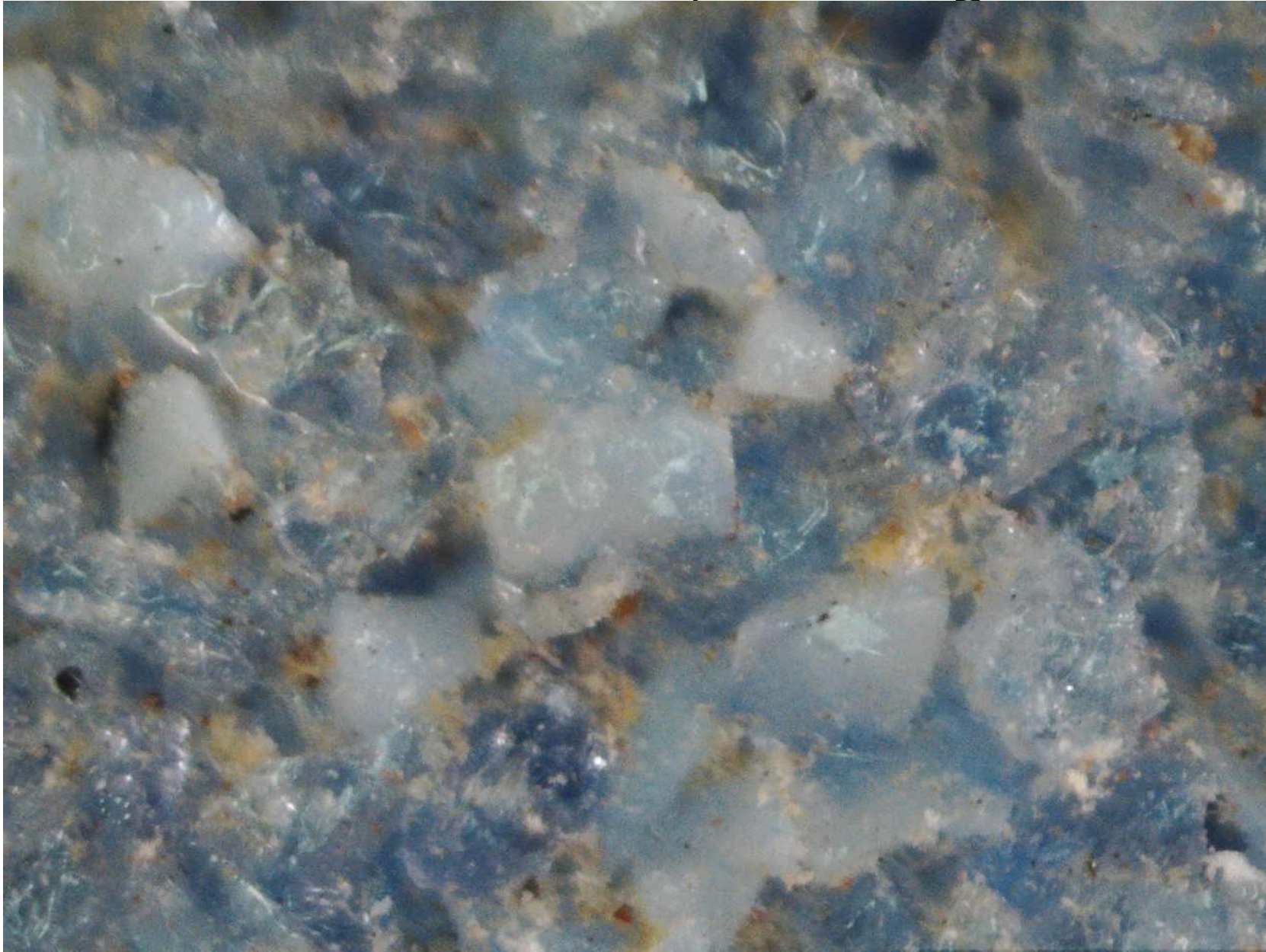




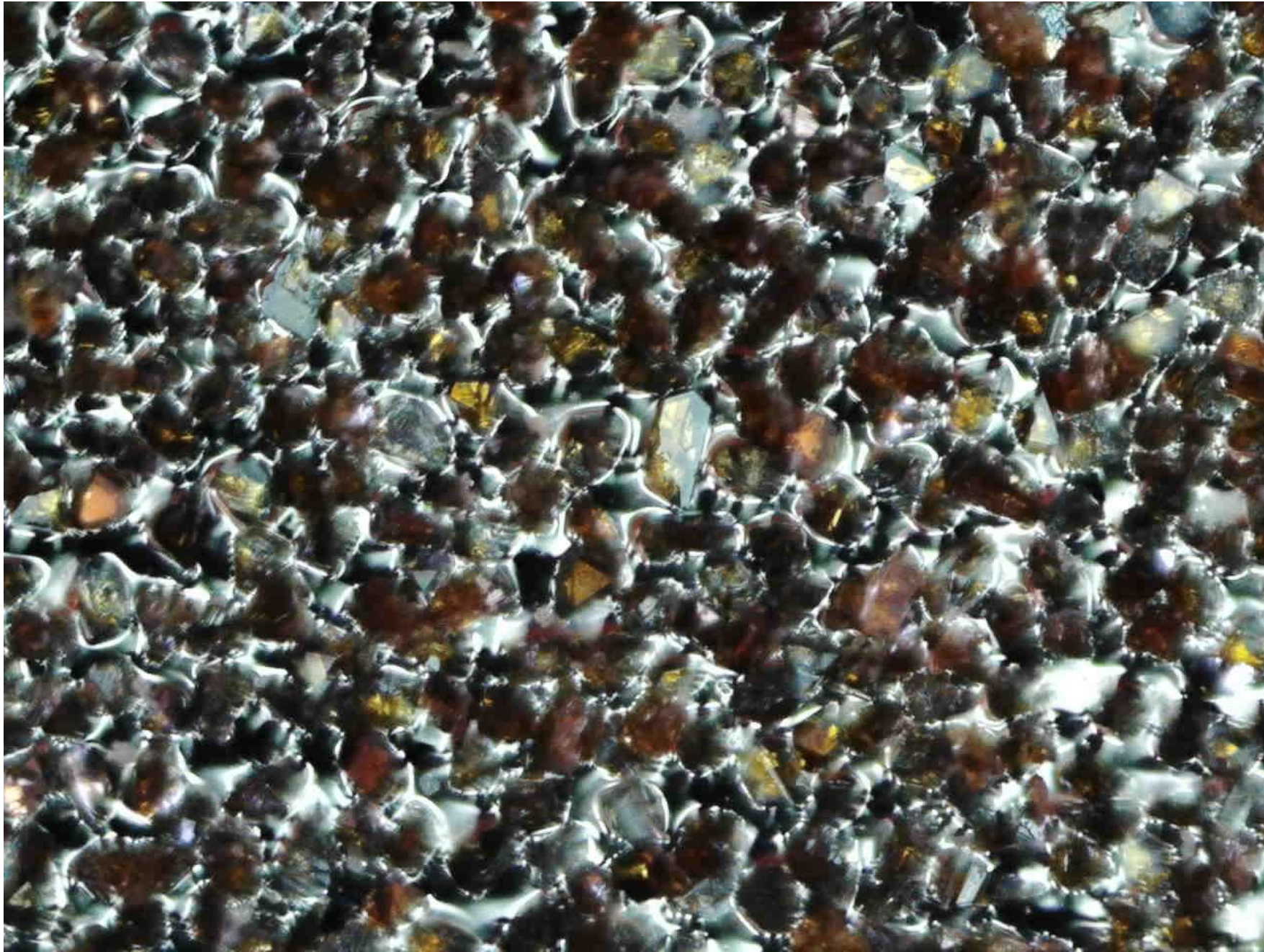
# Cutting edge of Particle Metal tool ground on CBN wheel



# Conventional Grinding Wheel with imbedded abrasive, 300X magnification

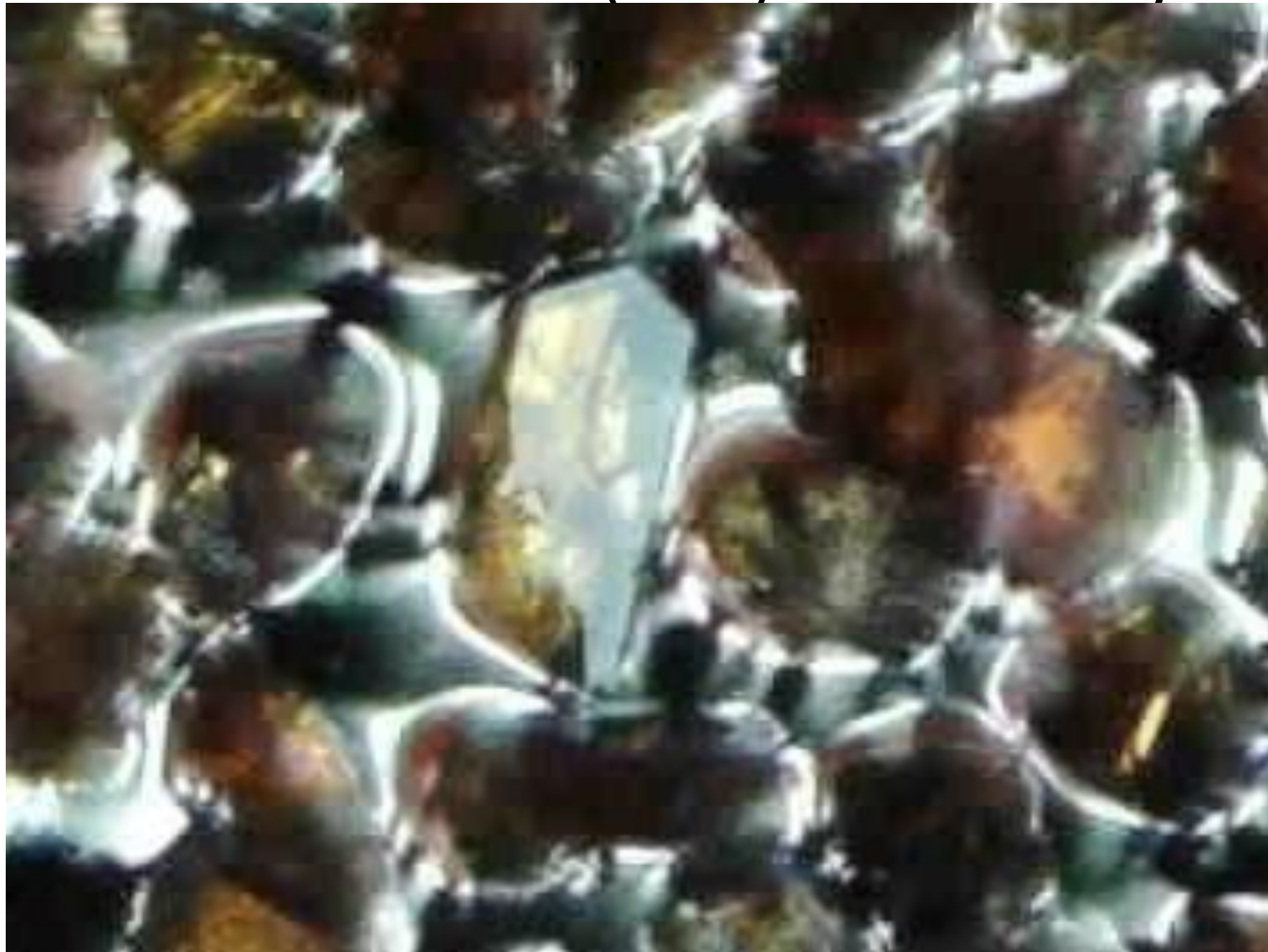


Cubic Boron Nitride (CBN) grinding wheel, 300X magnification





# Cubic Boron Nitride (CBN) Abrasive Crystal





Cubic Boron Nitride (CBN) molecule with one-to-one ratio of boron and nitrogen atoms





# Total Cost of Ownership

- Norton SG 8" grinding wheel costs \$105, lasts approximately 1 year (Seeded Gel is ceramic alumina)
- Typical CBN 8" grinding wheel costs \$185, lasts indefinitely
- Which has a lower total cost of ownership?



# Don't use diamond grinding wheels!

- Diamonds are pure carbon. Iron has an affinity for carbon
- When the diamond abrasive becomes hot, carbon transfers to the tool, rapidly wearing down the diamond abrasive
- Carbon transfers from the diamond abrasive to the tool, forming carbides at the cutting edge, damaging the tool.



# All tool steels are not created equal!

- Chemistry tolerances
- Refining process tolerances
- Rolling process
- Heat treating process
- Tempering process



# Let's examine grinds with 300X Microscope

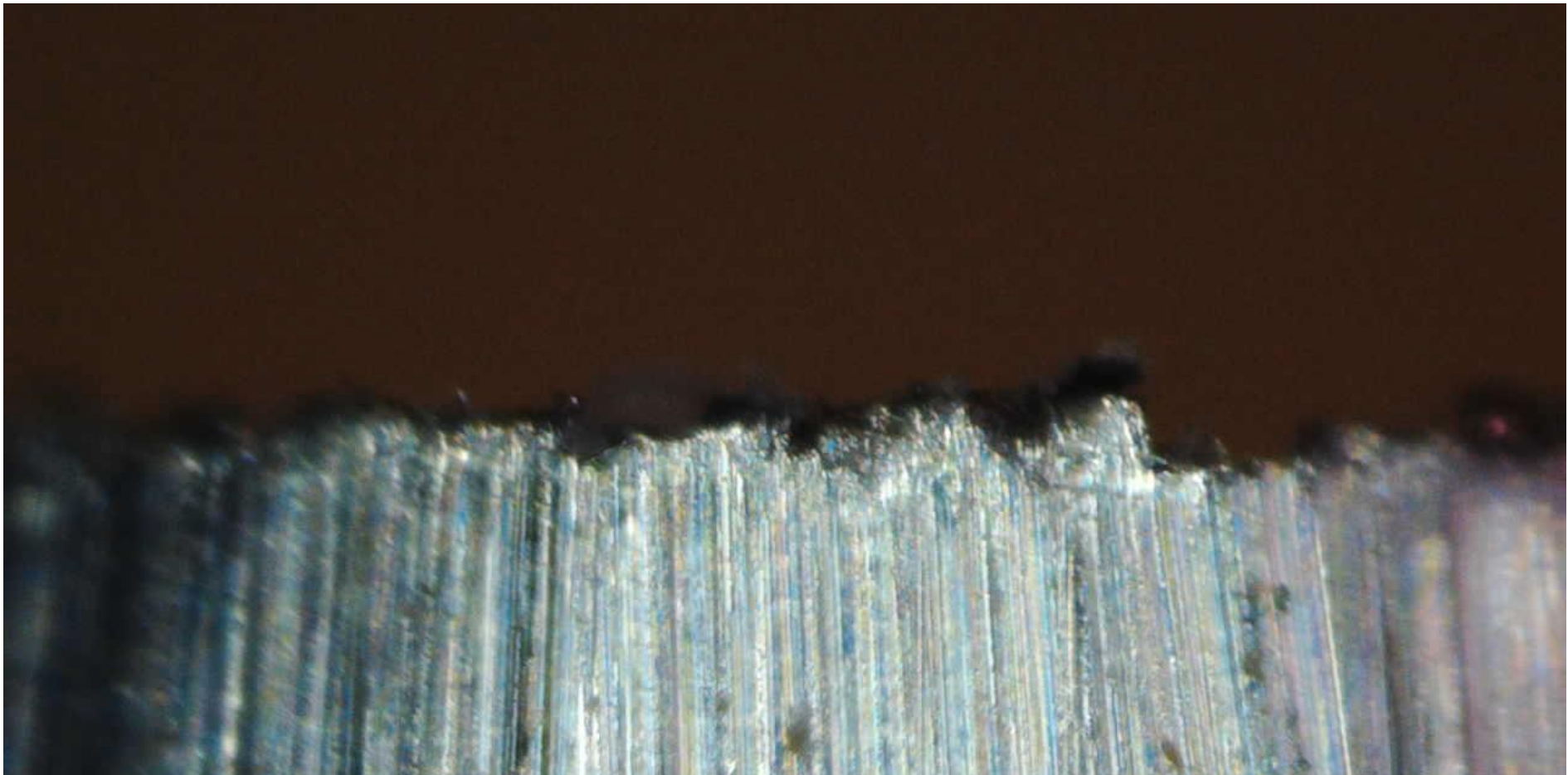
- M2 ground on conventional wheel
- CPM 10V ground on conventional wheel
- M2 ground on CBN wheel
- CPM 10V ground on CBN wheel



# Findings and Conclusions



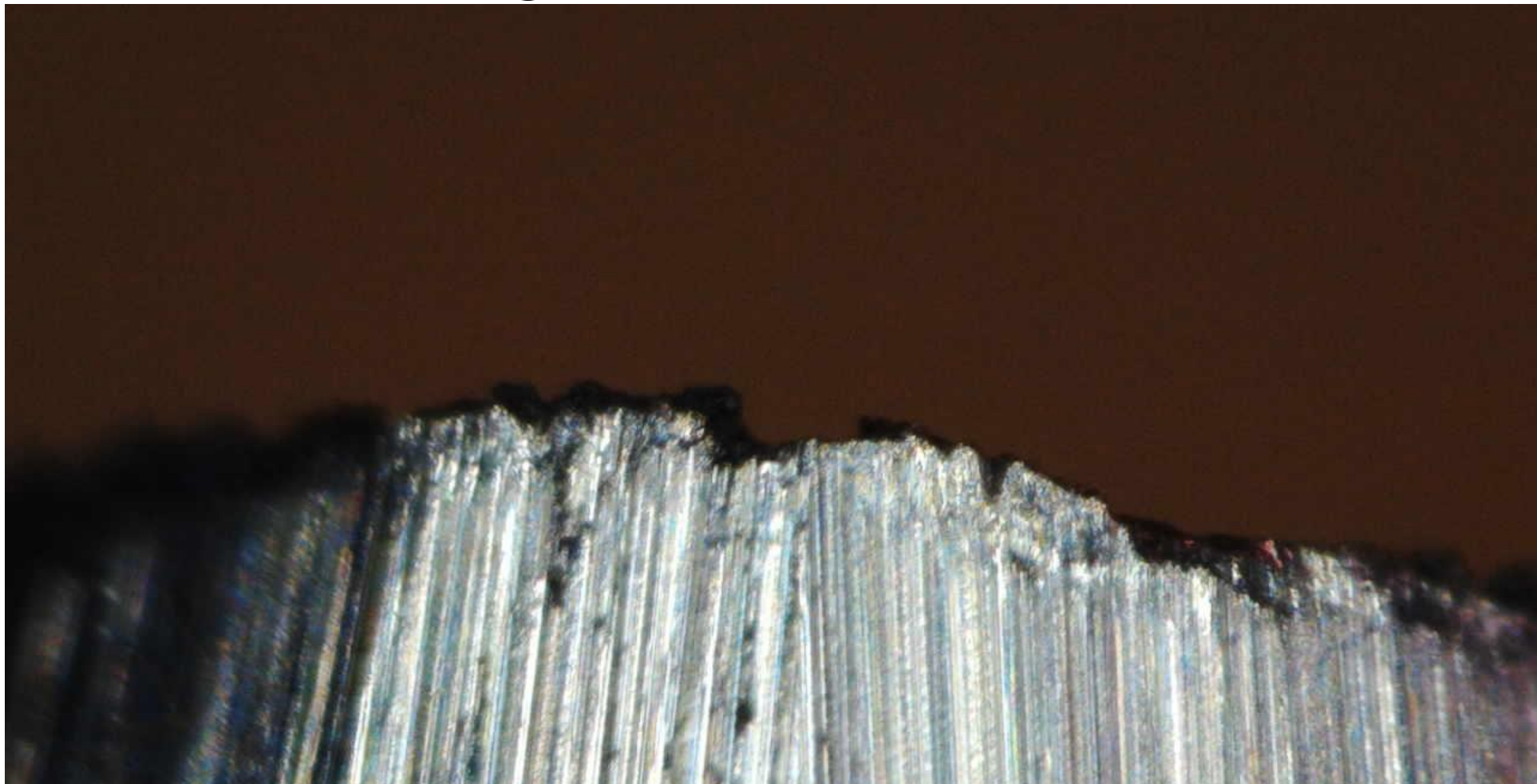
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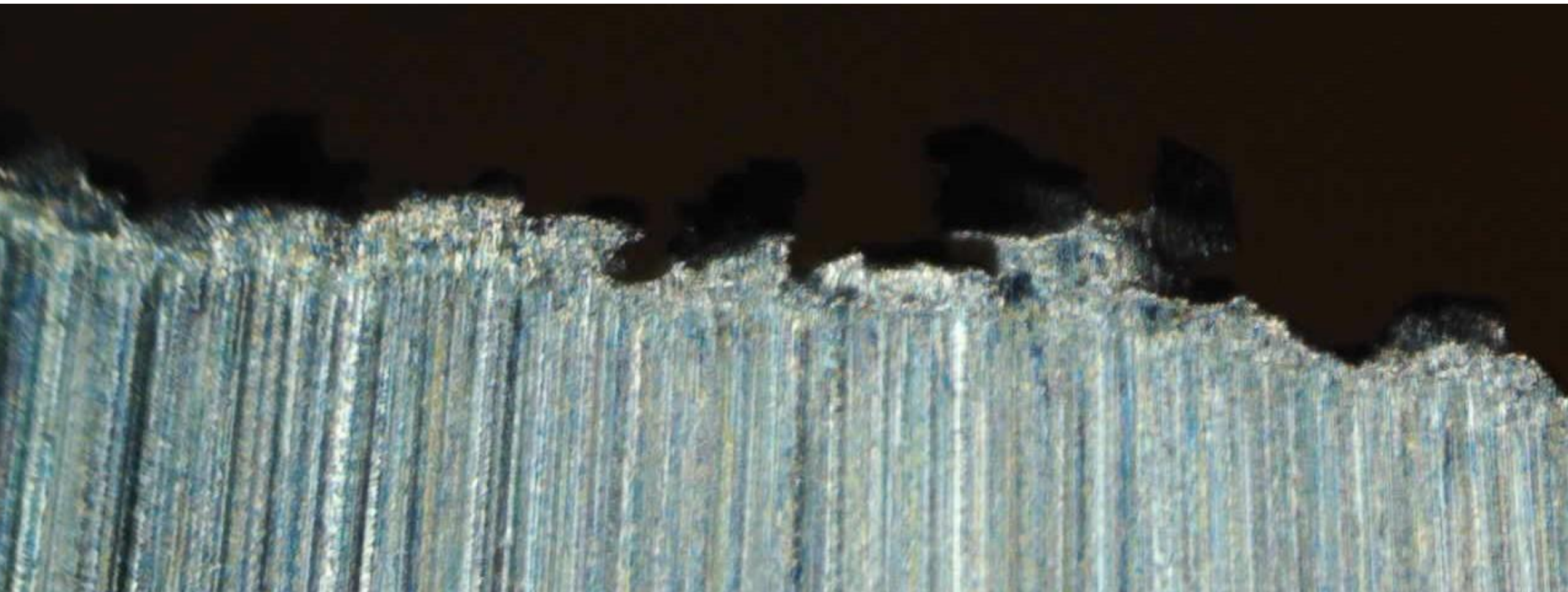


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