

Project # 206-293

TG Tools United Co.

Performance and Endurance Testing
Cutting Tools

Monday, October 23, 2006



ISO/IEC 17025 Accredited Laboratory
Certificate Number AT-1119

Prepared for: TG Tools United Co.
1010 Cedar Ave.
St. Charles, IL 60174
Attn: Ms. Rainbow Wang
(800) 687-4122

By: Atif A. Odeh, Principal Metallurgical Engineer
Christopher Page, Sr. Engineering Technician
Steve McDaniel, Failure Analysis Engineer
Matt Strack, Metallurgical Lab Technician

SAMPLE INFORMATION:

Drill Bits:

TG KIK – ¼” (KIK Point)
TG HSS – ¼” (KIK Point)
Hitachi Black Shield – ¼” (Split Point)
Hitachi Black Gold – 17/64” (Split Point)
DeWalt Brad Point – ¼” (Spur Point)

Forstner Bits:

TG Forstner – 1”
Wolcraft Forstner – 1”

Spade Bits:

TG Spade – 7/8” (KIK Point)
Irwin Speedbor – 7/8” (3 Points)

Test Methods and Procedures:

1. Thin Sheet Metal – Slippage
Draws Squares formed by cross lines
Back material – any wood
Hand Power Tools – Drill straight down
Starts pointing any cross
Scale under wood – 25Lbs pressure, full power

Regular Brad Point
Regular HS Drill Bit
KIK Brad Point - how much less slippage if there is
KIK HS Drill Bit – how much less slippage if there is
2. Sheet brass – Ability of KIK Spade drill none-ferrous sheet metal
Hand Power Tools – Drill straight down with back material wood
Check the hole's entry and exit

Test Methods and Procedures: “continued”

3. Acrylic - Cracking

Hand Power Tools – Drill straight down
Scale under wood – 25Lbs pressure, full power

Regular HS Drill Bit

KIK Brad Point – how much less cracking if there is

KIK HS Drill Bit – how much less cracking if there is

KIK Spade Bit – The ability to drill plastic

4. Oak – clean bottom blind hole and clean Entry and Exit

Hand Power Tool – Drill straight down

Scale under wood – 25Lbs pressure, full power

Regular Forstner

KIK Forster – cleaner bottom / Blind hole; cleaner Entry and Exit/ through hole

5. Thicker Sheet Metal – Entry and Exit/Burr

NO back material

Drill Press – Drill straight down

Scale under vise – 25Lbs pressure, 1500RPM

Regular HS Drill Bit

KIK Brad Point – how much cleaner of the entry, how much less burr if there is

KIK HS Drill Bit - how much cleaner of the entry, how much less burr if there is

Increase pressure to over 50lbs – twice fast drilling still produce better hole.

KIK HS Drill Bit

(Normally, less good result hole produced when pressure is higher.)

Test Methods and Procedures: “continued”

6. Oak – Speed compare

NO back material

Drill Press – Drill straight down

Scale under vise – 25Lbs pressure 1500RPM

Regular HS Drill Bit

Regular Brad Point

KIK Brad Point – how much faster than regular brad point, how much faster than regular HS drill bit

KIK Forstner – how much faster than regular forstner

Regular Forstner

7. Oak – Life

NO back material

Drill Press – Drill straight down

Scale under vise – 25Lbs pressure 1500RPM

Regular Brad Point

Regular Forstner

KIK Brad Point - how much longer it'll last than regular brad point,

KIK Forstner – how much longer it'll last than regular Forstner

8. Metal Block – Speed Compare

NO back material

Drill Press – Drill straight down

Scale under vise – 125Lbs pressure 1500RPM

Regular HS Drill Bit

KIK HS Drill Bit – how much faster it'll do the work

Test Methods and Procedures: “continued”

9. Metal Block – life
NO back material
Drill Press – Drill straight down
Scale under vise – 125Lbs pressure 1500RPM

Regular HS Drill Bit

KIK HS Drill Bit – how much longer it'll last
10. Wood Block – Ability to produce curve path
Hand power tool

Regular Spade
KIK Spade
Regular Forstner
KIK Forstner
11. Wood Block – ability to routes
Hand power tool

Regular Forstner
KIK Forstner

Mechanical TEST DATA AND RESULTS:

Drill Bits: Roundness of Bore Test:

Test material: Stainless steel sheet 0.02" thickness.

Samples of TG KIK produced holes of exceptional roundness.

Samples of TG HSS produced slightly elongated holes.

Samples of Hitachi Black Shield and Hitachi Black Gold caused severe deformation of the test material upon penetration.



TG HSS



TG KIK



Hitachi Black Shield



Hitachi Black Gold

Mechanical TEST DATA AND RESULTS: “Continued”

Drill Bits: Cutting Time in Wood:

Test material: Untreated oak board 0.75” thickness.

TG KIK produced a through hole in 1.35 seconds with 13 lbs. force.

Hitachi Black Shield produced a through hole in 1.90 seconds with 13 lbs. force.

DeWalt Brad Point produced a through hole in 3.85 seconds with 13 lbs. force.

Forstner Bits: Cutting Time in Wood:

Test material: Untreated oak board 0.75” thickness.

TG Forstner bit produced a through hole in the test board in 22.56 seconds with a 30 lbs. force.

TG Forstner bit maximum through hole speed was 3.53 seconds.

Wolcraft Forstner bit produced a through hole in the test board in 48.50 seconds with a 30 lbs. force.

Wolcraft Forstner bit maximum through hole speed was 6.30 seconds.

Forstner and Spade Bits: Curved Cut Ability:

Both TG Forstner and Spade bits were able to bore a 90 deg. curved through hole in a 4” X 4” wooden post.

Mechanical TEST DATA AND RESULTS: “Continued”

Forstner Bits: Exit Hole in Wood

The TG forstner bit produced a clean, splinter free exit hole in an untreated oak board.
The Wolcraft forstner bit left a splintered exit hole in the same untreated oak board.

TG Forstner Bit



Wolcraft Forstner Bit



Mechanical TEST DATA AND RESULTS: “Continued”

Drill Bits: Slippage Test:

Test material: Stainless steel sheet 0.025” thickness.

Product	Average Recorded Slippage (inches)
TG KIK	0.057
TG HSS	0.094
Hitachi Black Shield	0.083
Hitachi Black Gold	0.101

Mechanical TEST DATA AND RESULTS: “Continued”

Drill Bits: Exit Hole Burr Test:

Test material: Stainless steel sheet 0.02” thickness.



The Hitachi Black Gold produced an elongated hole with moderate burring at the exit.

The Hitachi Black Shield produced a consistently round hole with significant burring at the exit.

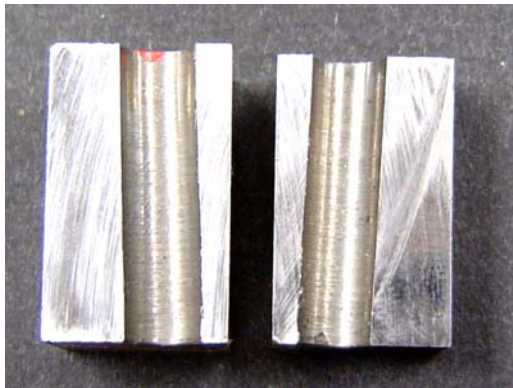
The TG HSS produced a consistently round hole with minor burring at the exit.

The TG KIK produced a consistently round hole with minor burring at the exit

Mechanical TEST DATA AND RESULTS: “Continued”

Drill Bits: Consistent Through Hole Test – Steel Plate:

Test material: Low carbon steel plate 1” thickness.



TG HSS



Hitachi Black / Gold Shield

The TG HSS produced significantly smoother and more consistent through hole than the Hitachi Black Shield.

Mechanical TEST DATA AND RESULTS: “Continued”

Drill Bits: Cutting Time in Acrylic Test:

Test material: Acrylic plate 0.70” thickness.

TG KIK produced a through hole in 1.42 seconds with 30 lbs. force

Hitachi Black Shield produced a through hole in 3.22 seconds with 30 lbs. force

DeWalt Brad Point produced a through hole in 11.16 seconds with 30 lbs. force

Forstner Bits: Cutting Ability Test – Acrylic:

Test material: Acrylic plate 0.70” thickness.

Both the TG Forstner and TG spade bits were able to satisfactorily bore into the acrylic test plate.

Spade Bits: Cutting Ability Test – Brass:

Test material: Brass sheet 0.016” thickness.

The TG spade bit was able to cut a round section from the brass test plate.

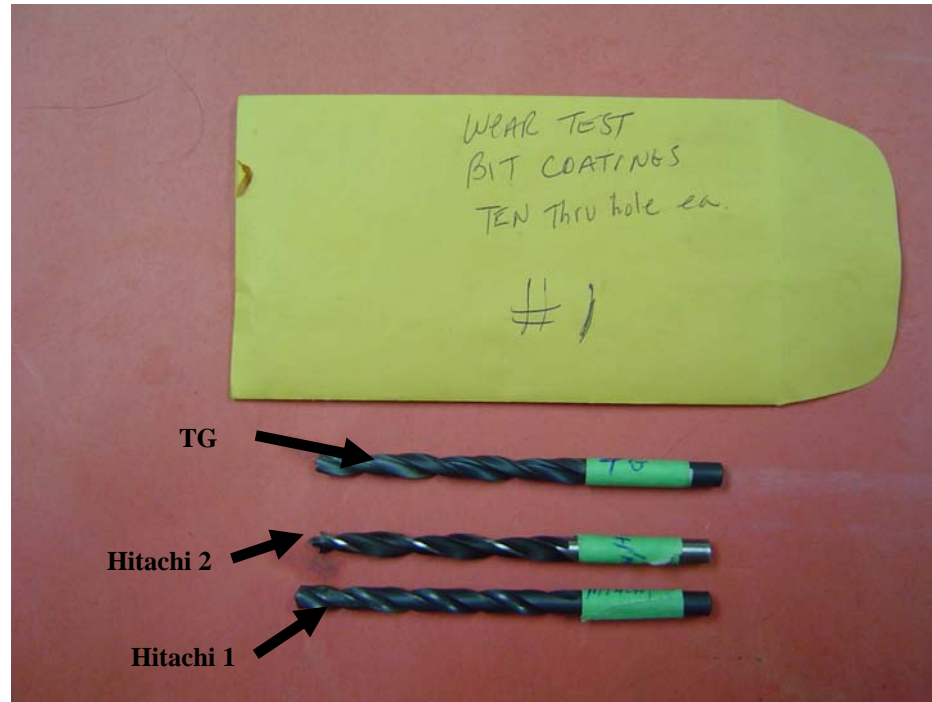
Metallurgical Examination Test Results:

Further testing on the metallurgical properties of the mechanically tested drills was conducted. This analysis as shown below was conducted on seven (7) drill bits from all three groups in order to compare the metallurgical properties of TG Tools samples to other samples.



(Fig. 1) All seven drill bits tested for metallurgical properties after mechanical testing

Group #1 – Metallurgical Examination Test Results



(Fig. 2) As received photo of group #1

Group # 1 - Metallurgical Examination Test Results: "Continued"

Microhardness Test Results

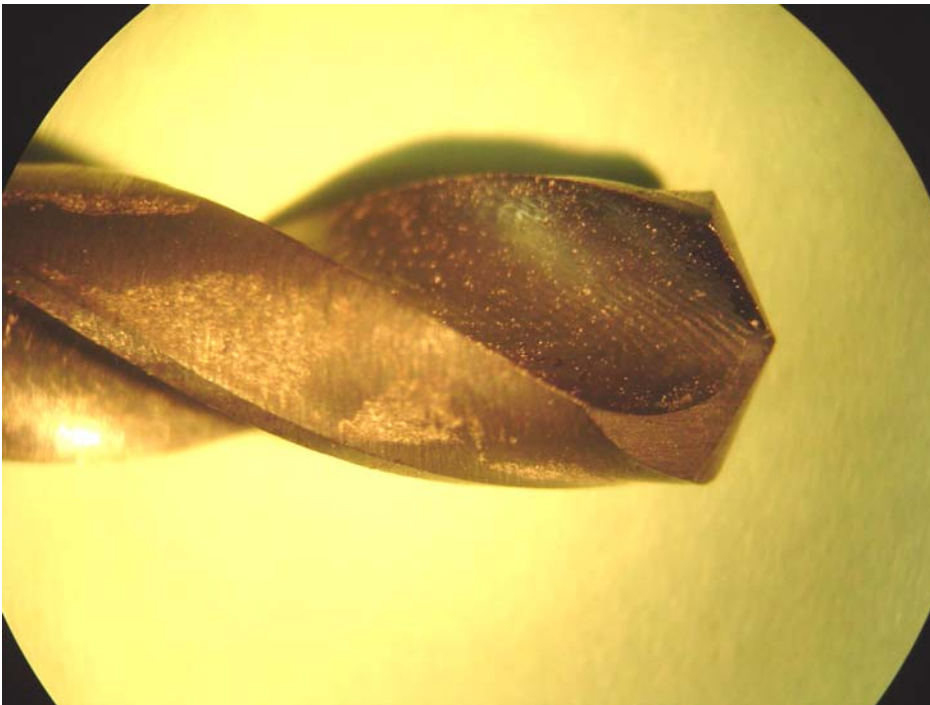
(500 gram load – Knoop - 50X Objective – 10s Dwell Time)

Distance from the Surface (in)	Hitachi 1 (RC)	Hitachi 2 (RC)	TG (RC)
.005" below cutting surface	58.9 (707.5HK)	66.0 (870.1HK)	62.9 (797.6HK)

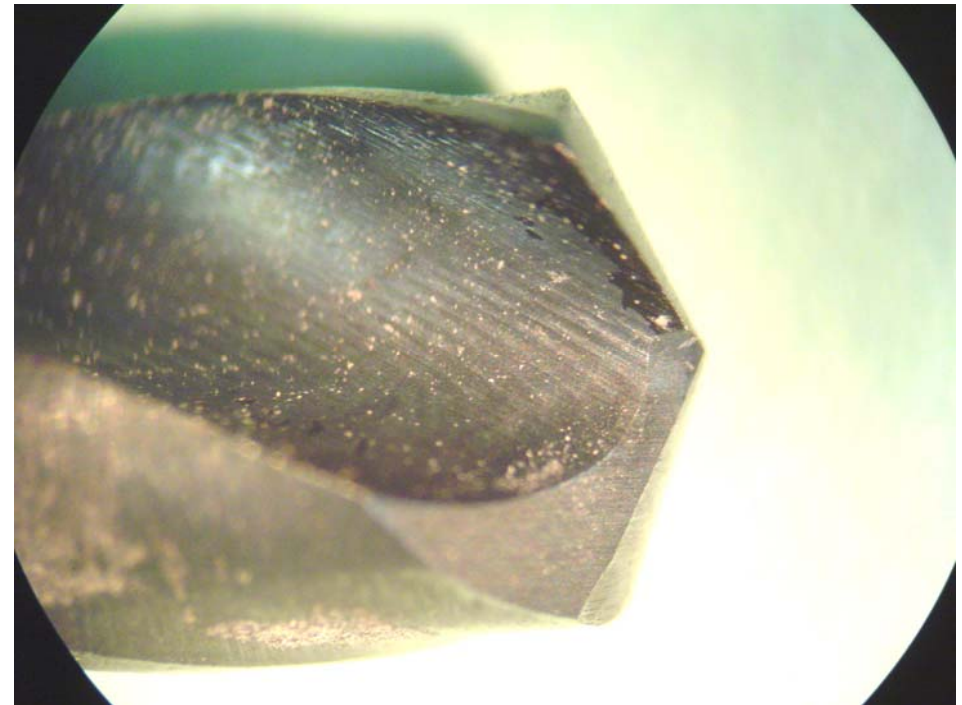
Preparation and testing performed in accordance with ASTM E3, E384 – latest revision

The first group of samples: Microhardness test results shows TG sample to be approximately 63 Rc in hardness where the Hitachi samples range from 59 to 66 Rc. It is our opinion that 63 Rc is more adequate for better performance as it is not too low such as 59 Rc where it can wear fast and not too hard such as 66 Rc where it can be brittle.

Group # 1 - Metallurgical Examination Test Results: "Continued"

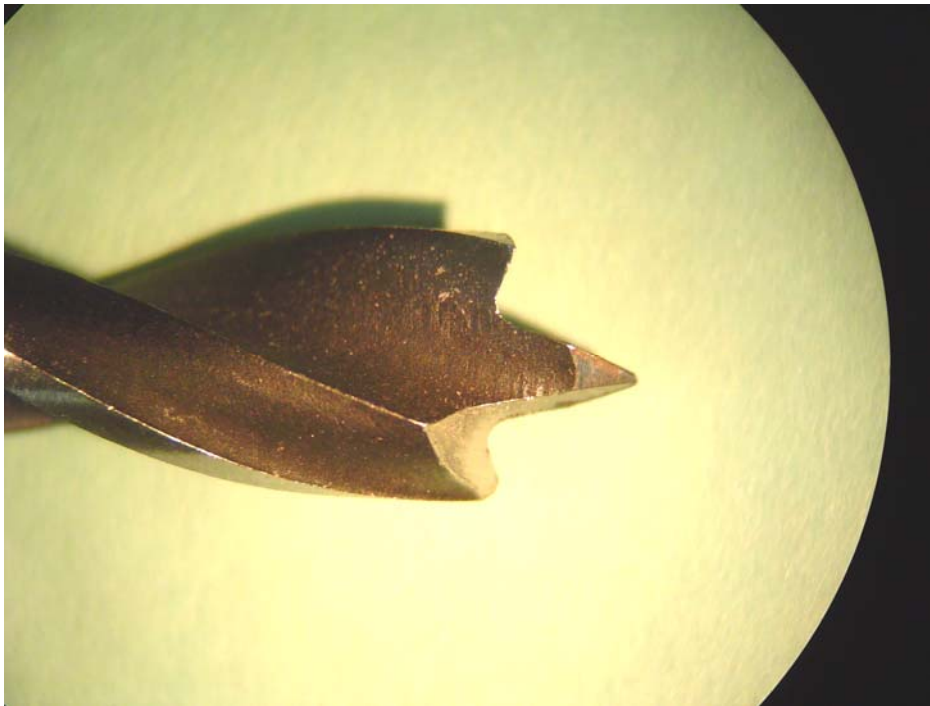


(Fig. 3) Hitachi 1 – photo showing cutting edge and some signs of

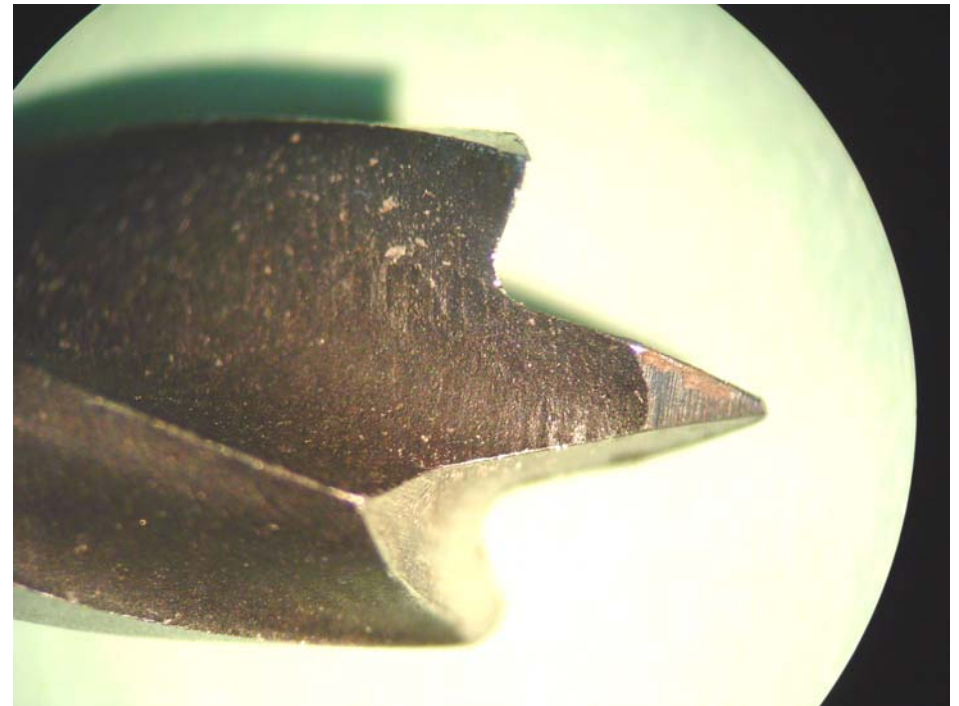


(Fig. 4) Hitachi 1 – higher magnification of cutting edge abrasion wear

Group # 1 - Metallurgical Examination Test Results: "Continued"



(Fig. 5) Hitachi 2 – photo showing cutting edge

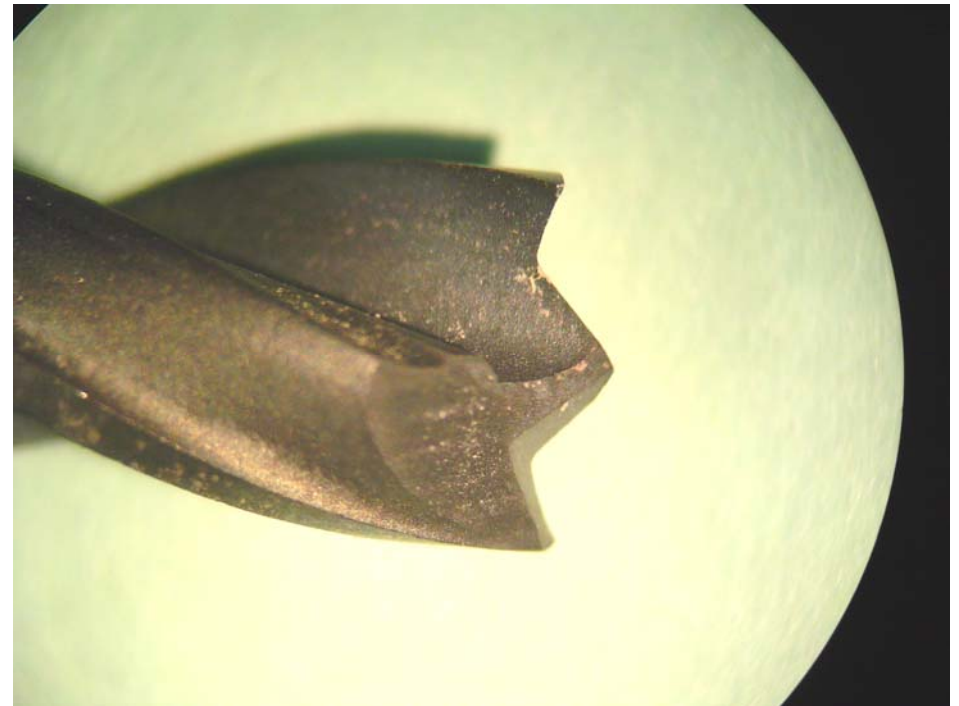


(Fig. 6) Hitachi 2 – higher magnification of cutting edge

Group # 1 - Metallurgical Examination Test Results: "Continued"

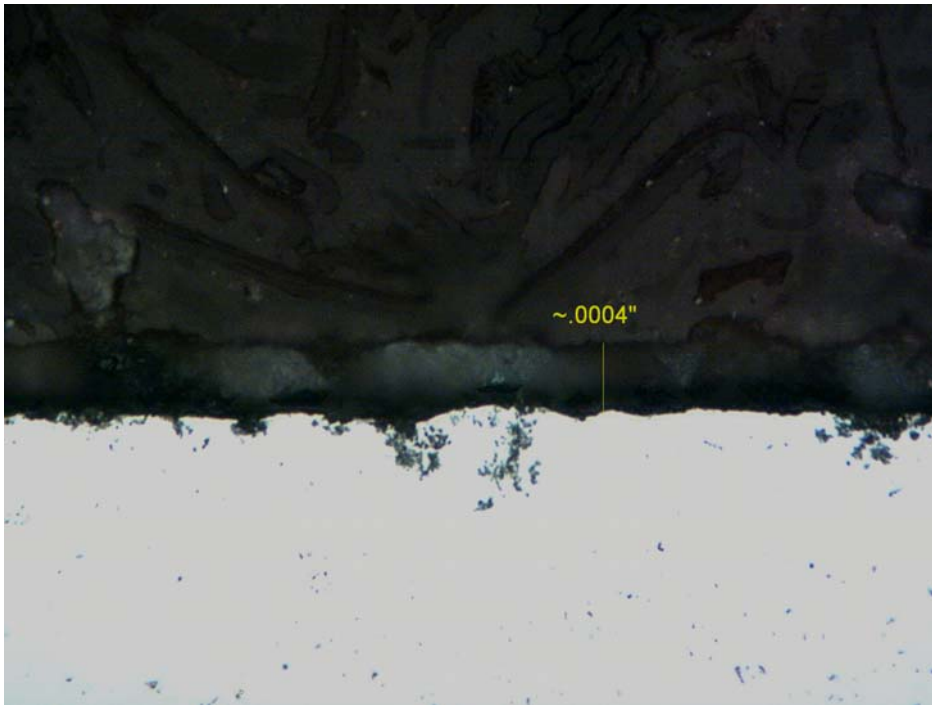


(Fig. 7) TG – photo showing cutting edge

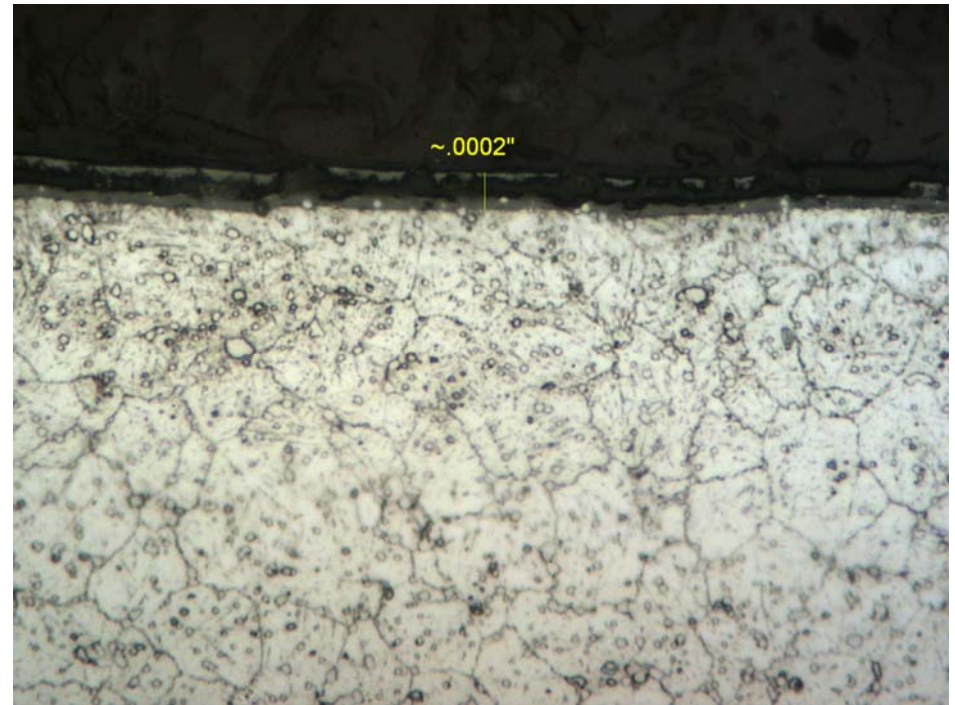


(Fig. 8) TG – higher magnification showing cutting edge – No signs of wear

Group # 1 - Metallurgical Examination Test Results: "Continued"

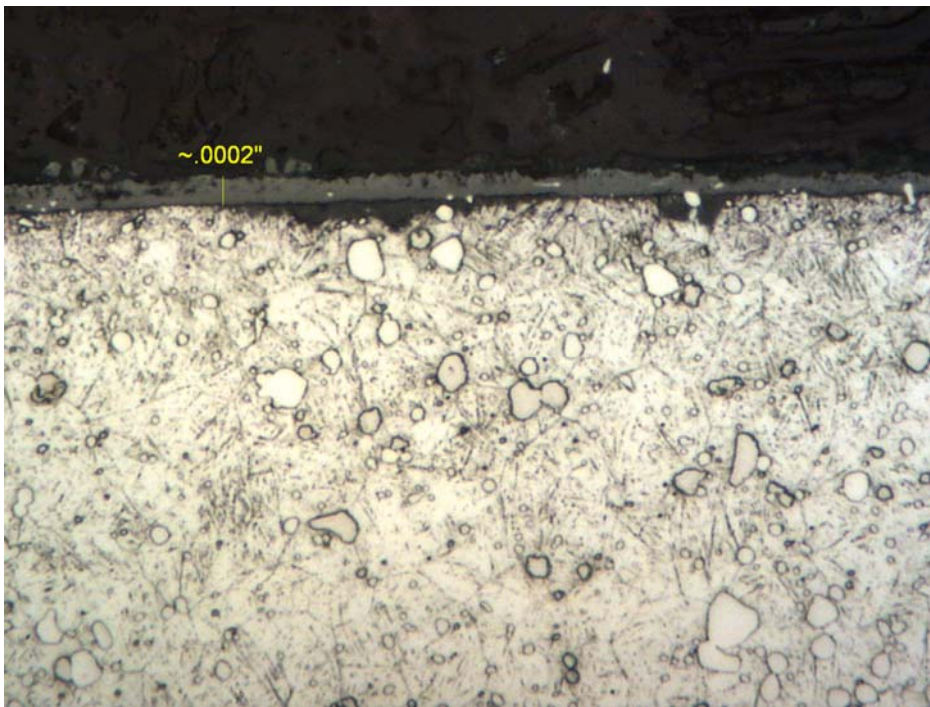


(Fig. 9) 1000x - Hitachi 1 surface – coating is ~.0004"

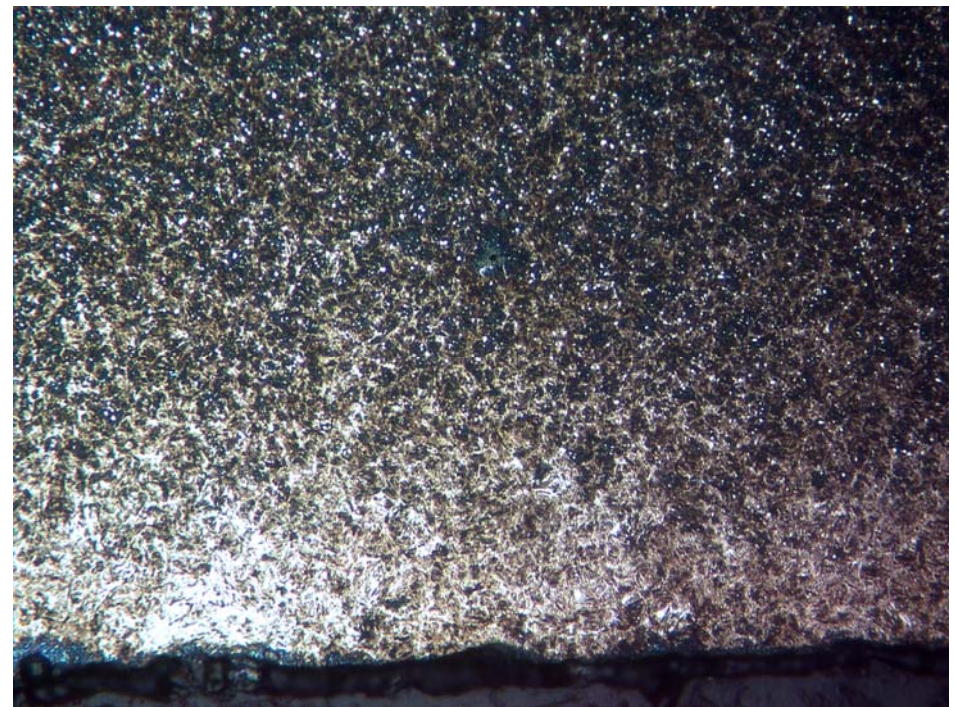


(Fig. 10) 1000x - Hitachi 2 Surface – coating is ~.0002"

Group # 1 - Metallurgical Examination Test Results: "Continued"

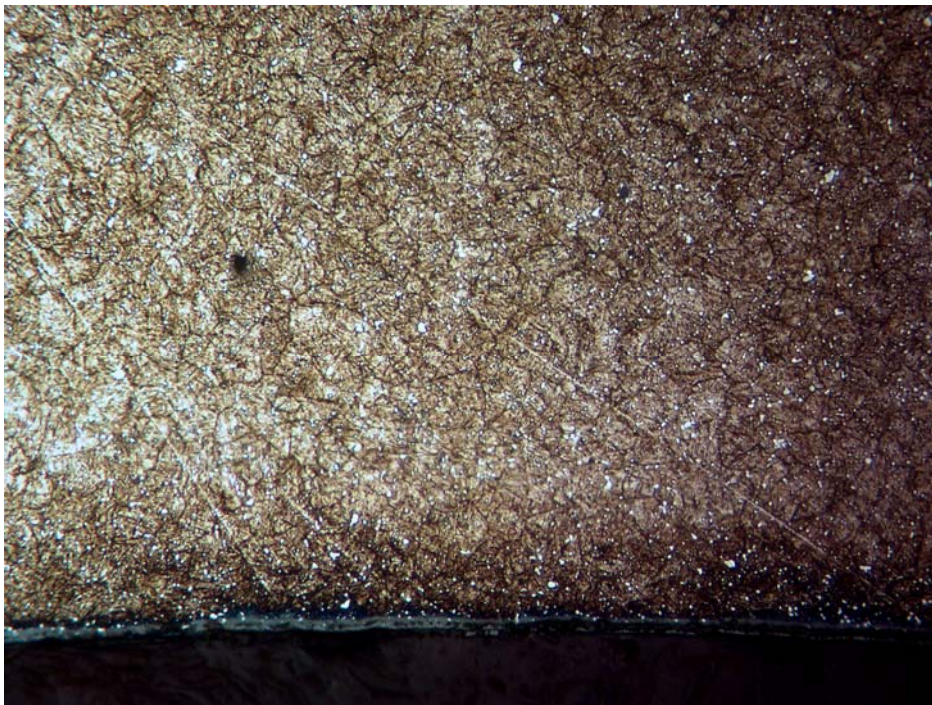


(Fig. 11) 1000x - TG Surface – coating is ~.0002"

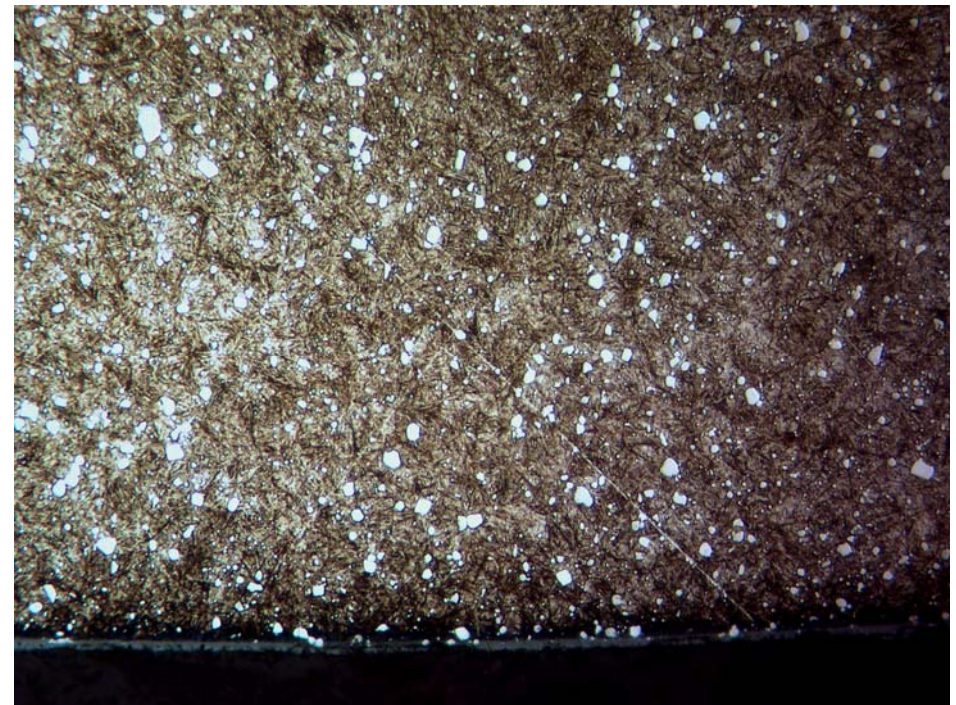


(Fig. 12) 400x - Hitachi 1 – Surface microstructure – Scattered pin point carbides in a matrix of tempered Martensite – Note some partial decarburization at surface approximately .003" deep.

Group # 1 - Metallurgical Examination Test Results: "Continued"



(Fig. 13) 400x - Hitachi 2 – Surface microstructure – Tempered Martensite



(Fig. 14) 400x - TG – Surface microstructure – Tempered Martensite

Group #2 – Metallurgical Examination Test Results



(Fig. 15) As received photo of group #2

Group # 2 - Metallurgical Examination Test Results: "Continued"

Microhardness Test Results

(500 gram load – Knoop - 50X Objective – 10s Dwell Time)

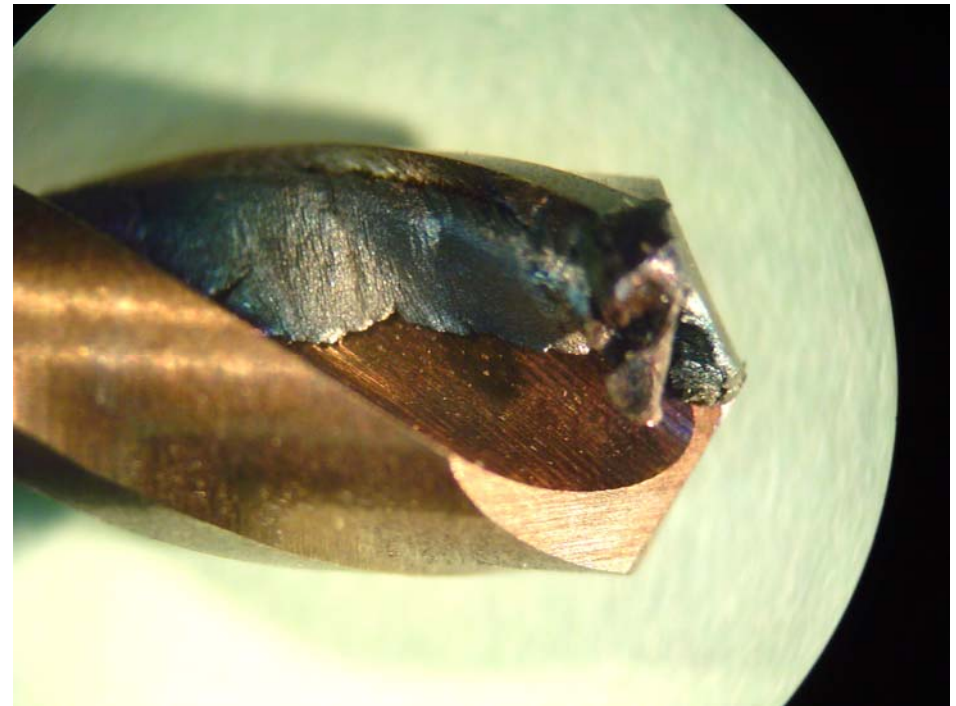
Distance from the Surface (in)	17/64 (RC)	TG (RC)
.005" below cutting surface	66.0 (870.9HK)	60.7 (748.2HK)

Preparation and testing performed in accordance with ASTM E3, E384 – latest revision

Group # 2 - Metallurgical Examination Test Results: "Continued"

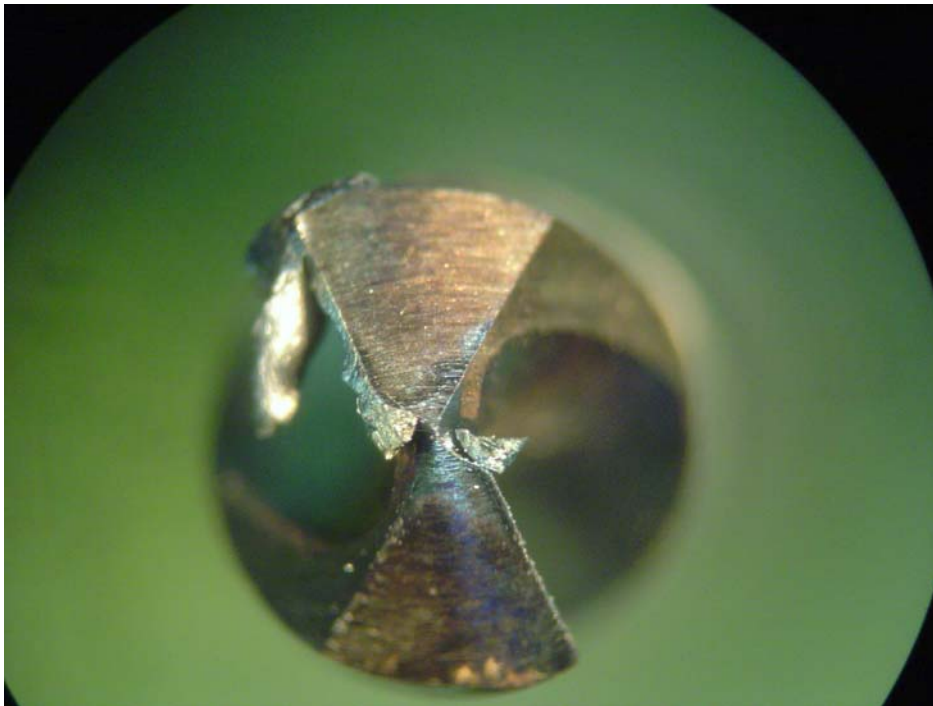


(Fig. 16) 17/64 – photo showing cutting edge. Note material build up on flute

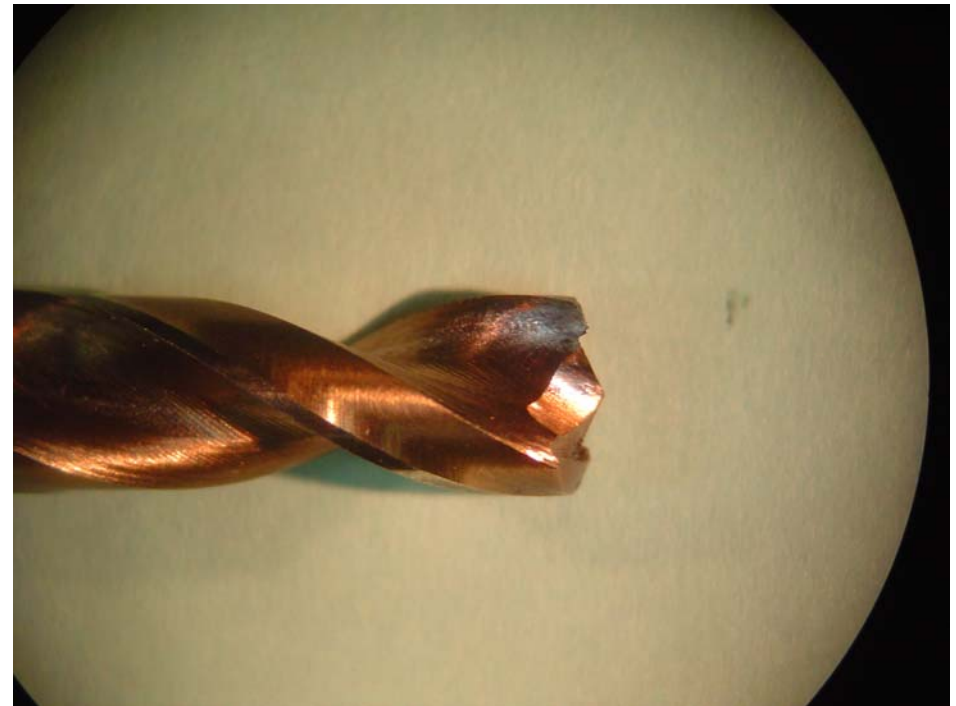


(Fig. 17) 17/64 – Note heating on the flute of the drill and severe burning and melting / material roll over

Group # 2 - Metallurgical Examination Test Results: "Continued"



(Fig. 18) 17/64 – Higher magnification showing severe heating of cutting edge



(Fig. 19) TG – Note slight burning on cutting edge

Group # 2 - Metallurgical Examination Test Results: "Continued"



(Fig. 20) TG – higher magnification of burning on cutting edge
– Minimal and no material roll over or melting present compared to competitor's figure number 17

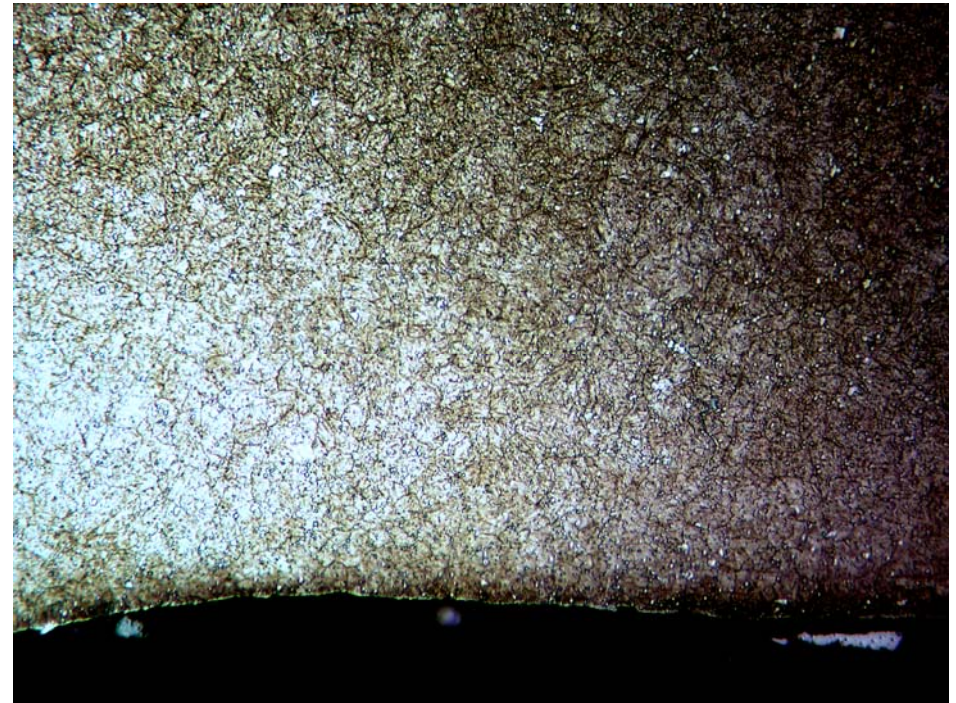


(Fig. 21) 1000x - 17/64 Surface – coating is ~.0001"

Group # 2 - Metallurgical Examination Test Results: "Continued"

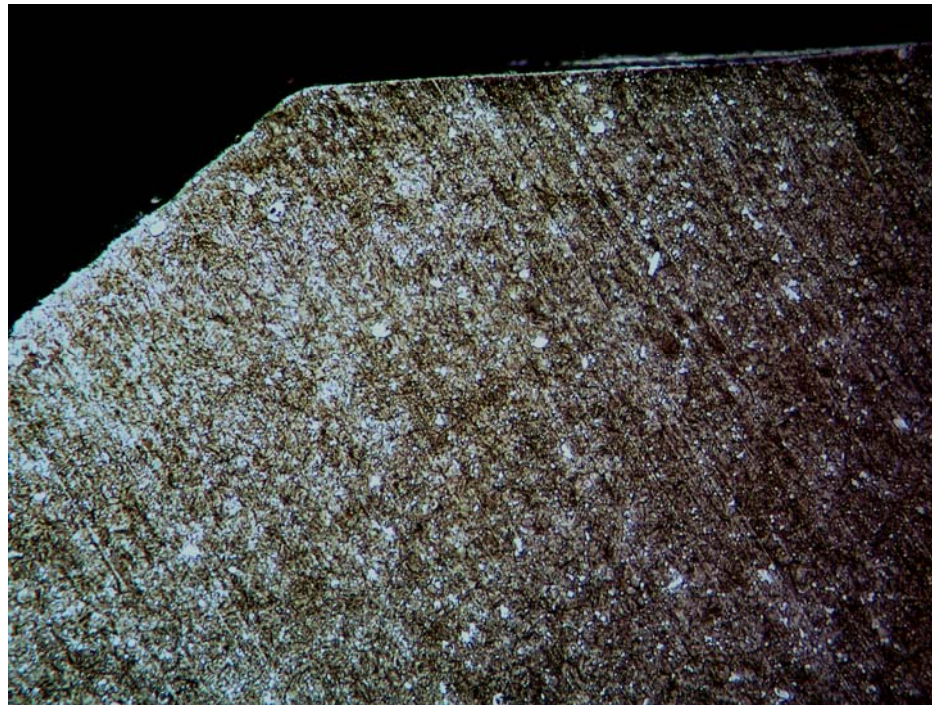


(Fig. 22) 1000x - TG surface – coating is ~.0001"



(Fig. 23) 400x - 17/64 – Surface microstructure – Tempered Martensite with burned (tempered back) structure

Group # 2 - Metallurgical Examination Test Results: "Continued"



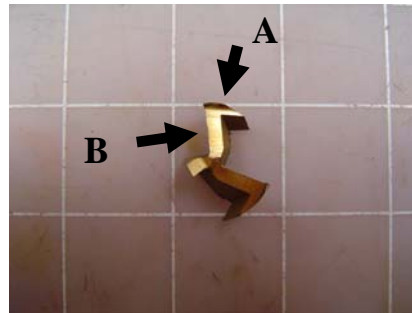
(Fig. 24) 400x -TG – Surface microstructure
Uniform Tempered Martensite – No signs of burning

Group #3 – Metallurgical Examination Test Results



(Fig. 25) As received photo of group #3

Group # 3 - Metallurgical Examination Test Results: "Continued"



(Fig. 26) Photo indicates where two samples from TG were taken

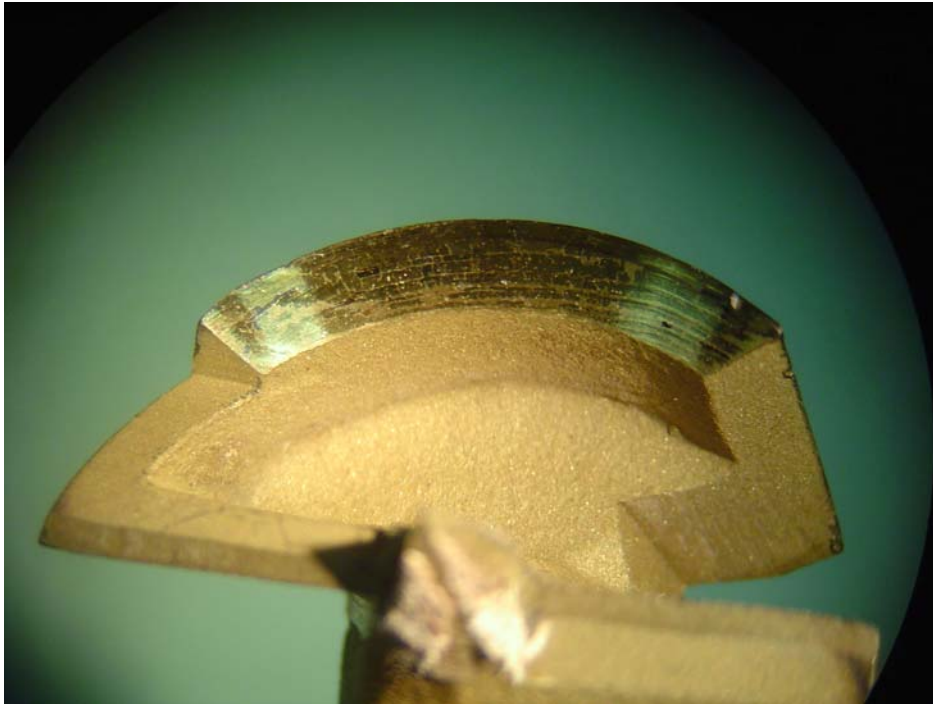
Microhardness Test Results

(500 gram load – Knoop - 50X Objective – 10s Dwell Time)

Distance from the Surface (in)	TG (RC)	Wolfcraft - A (RC)	Wolfcraft - B (RC)
.005" below cutting surface	54.4 (618.5HK)	49.8 (539.6HK)	50.8 (554.5HK)

Preparation and testing performed in accordance with ASTM E3, E384 – latest revision

Group # 3 - Metallurgical Examination Test Results: "Continued"

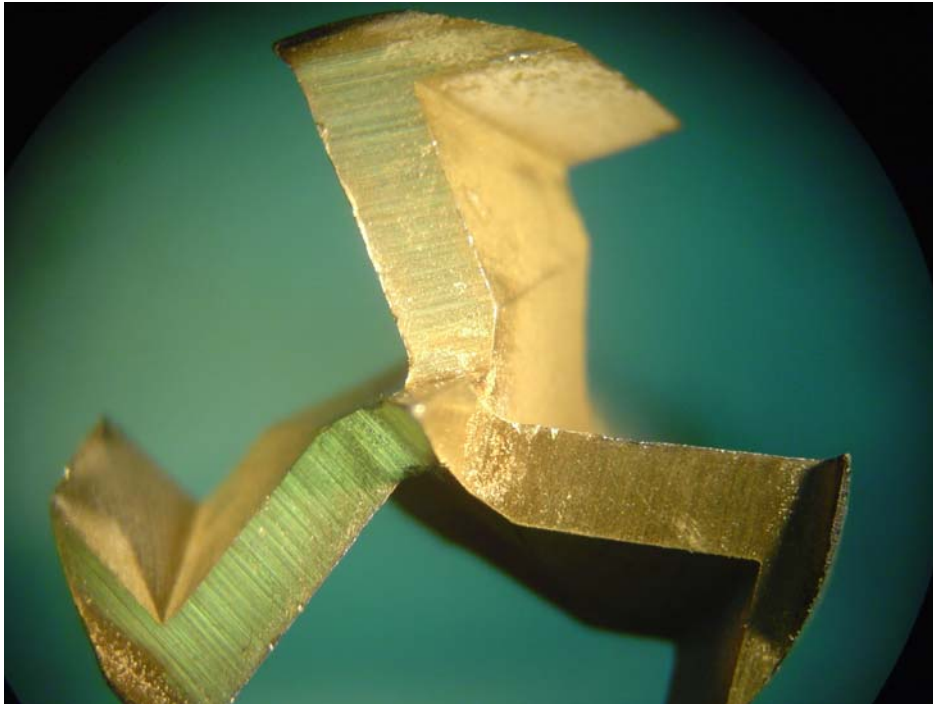


(Fig. 27) Wolcraft – photo showing cutting edge

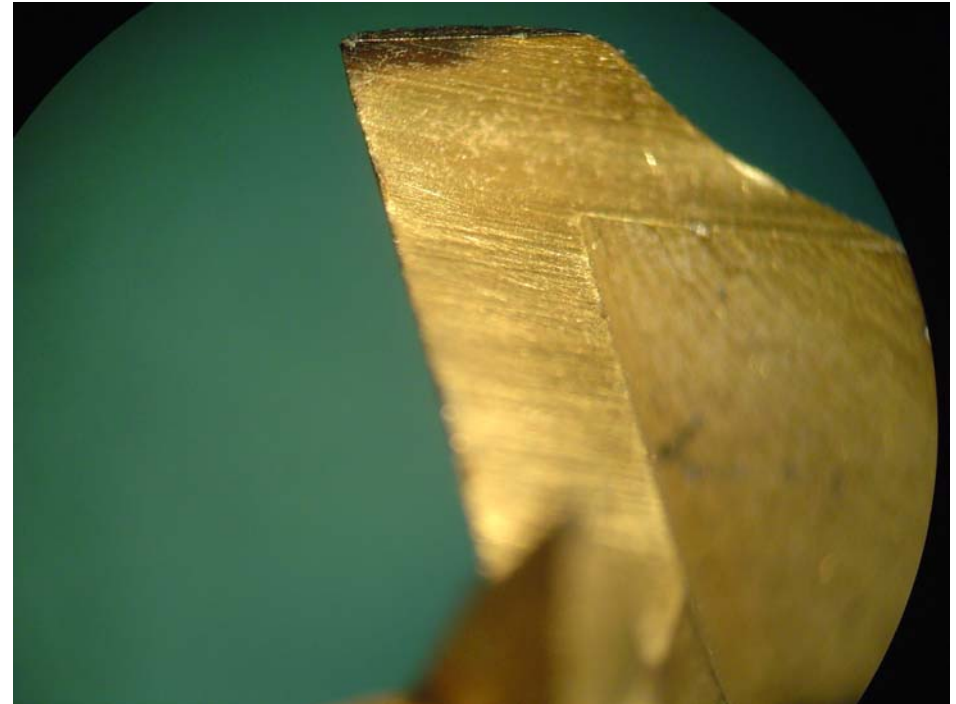


(Fig. 28) Wolcraft – higher magnification of cutting edge

Group # 3 - Metallurgical Examination Test Results: "Continued"

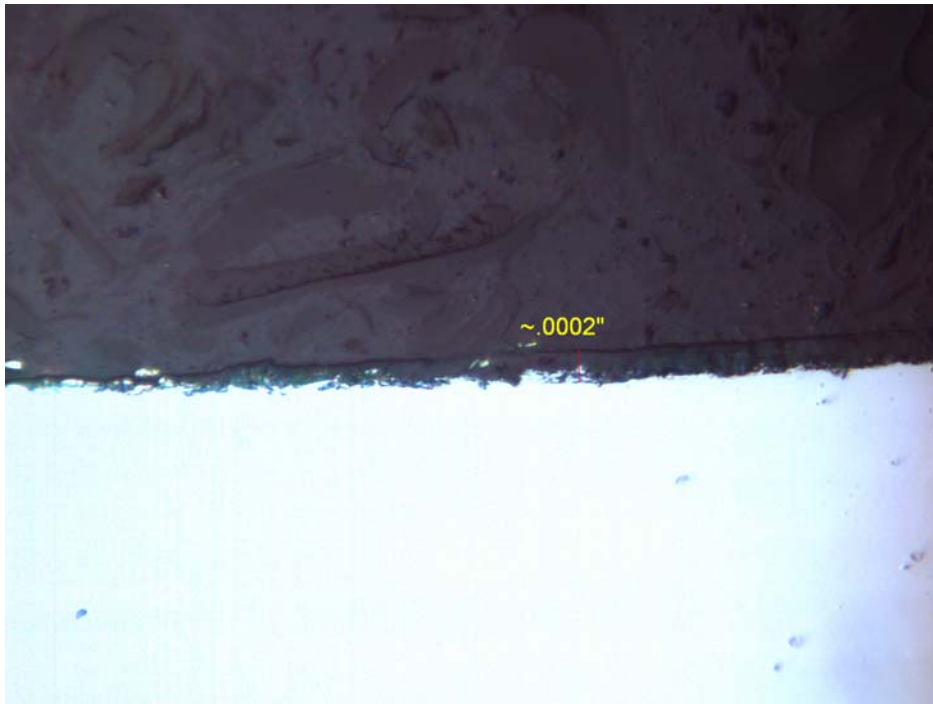


(Fig. 29) TG – photo showing cutting edge

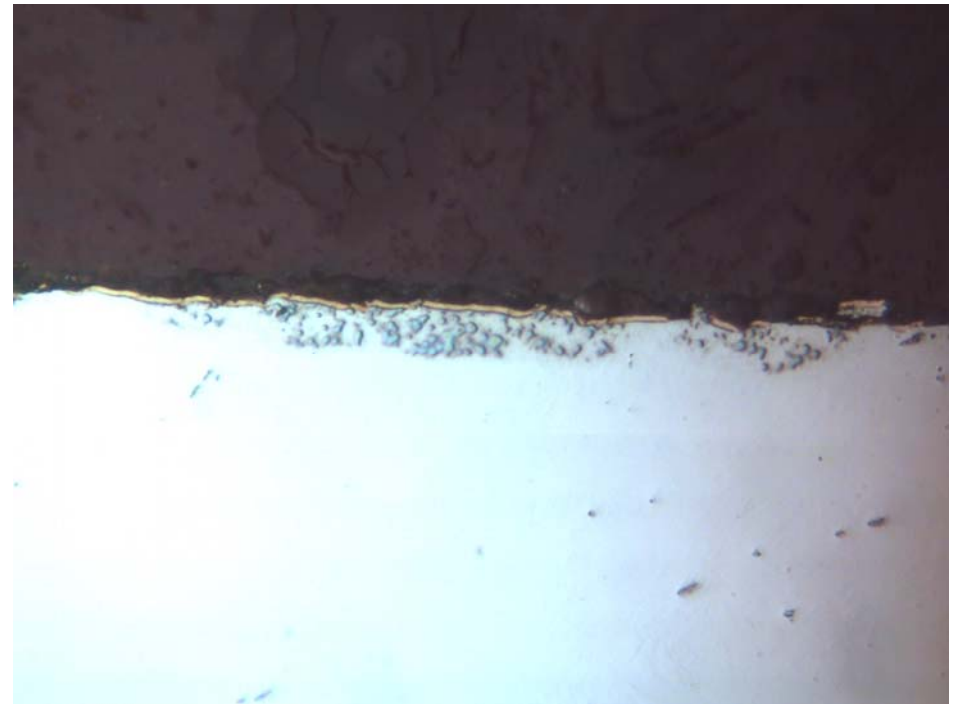


(Fig. 30) TG – higher magnification of cutting edge

Group # 3 - Metallurgical Examination Test Results: "Continued"

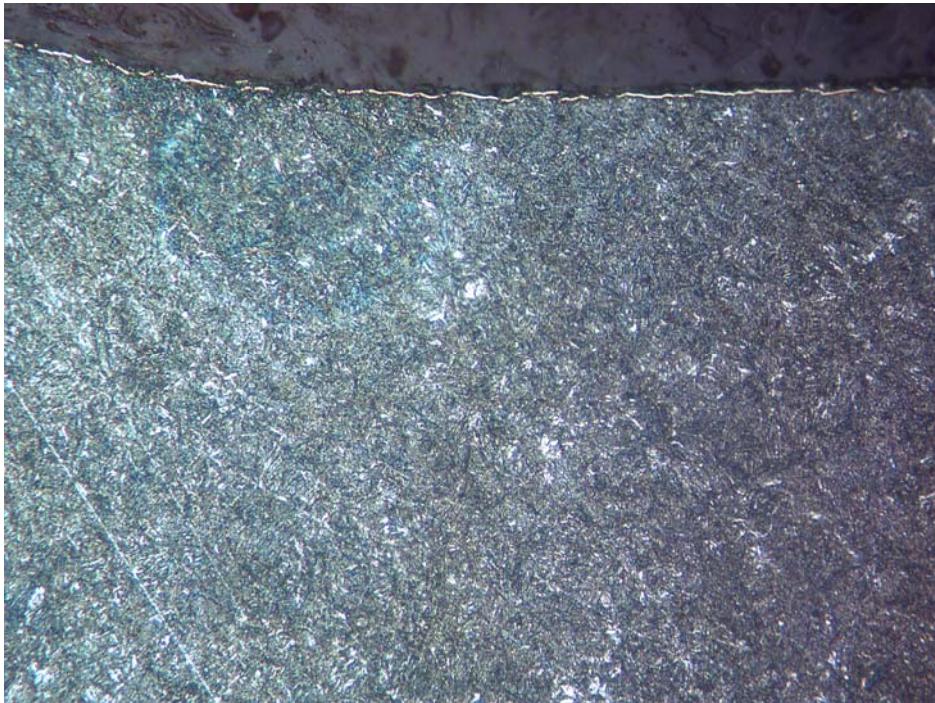


(Fig. 31)1000x – Wolfcraft – coating is ~.0002"

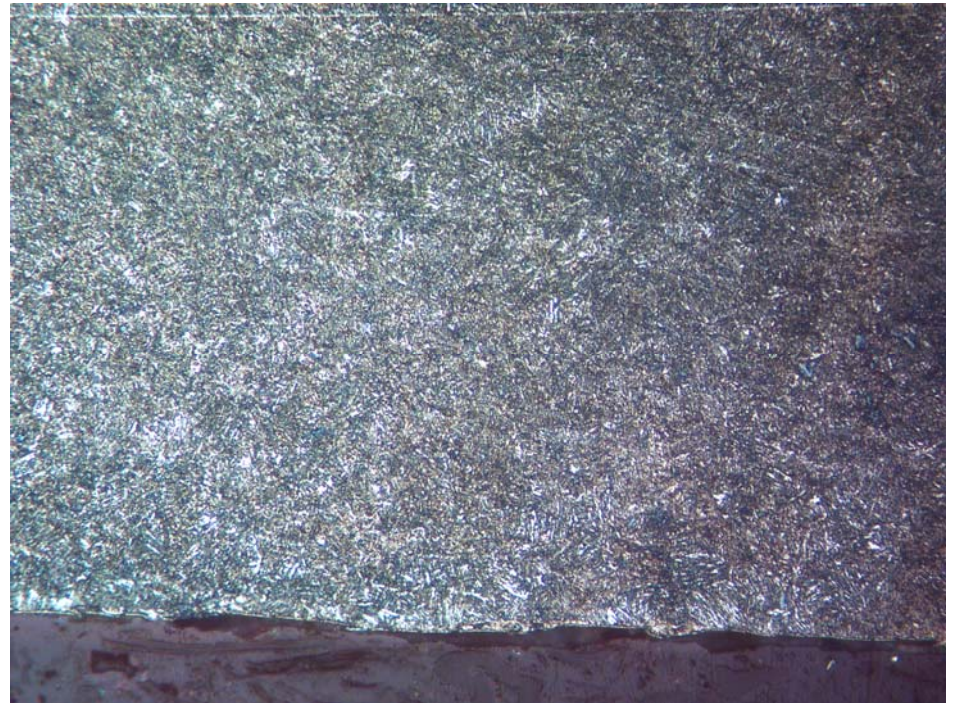


(Fig. 32)1000x - TG - Location A – coating thickness ~.00004"

Group # 3 - Metallurgical Examination Test Results: "Continued"



(Fig. 35) 400x – TG – Location A – Surface microstructure - Tempered Martensite



(Fig. 36) 400x - TG – Location B – Surface microstructure - Tempered Martensite

Summary of Test Results

Drill Bits: Roundness of Bore Test:

Test material: Stainless steel sheet 0.02" thickness.

Samples of TG KIK produced holes of exceptional roundness.

Samples of TG HSS produced slightly elongated holes.

Samples of Hitachi Black Shield and Hitachi Black Gold caused severe deformation of the test material upon penetration.

Drill Bits: Cutting Time in Wood:

Test material: Untreated oak board 0.75" thickness.

TG KIK produced a through hole in 1.35 seconds with 13 lbs. force.

Hitachi Black Shield produced a through hole in 1.90 seconds with 13 lbs. force.

DeWalt Brad Point produced a through hole in 3.85 seconds with 13 lbs. force.

Forstner Bits: Cutting Time in Wood:

Test material: Untreated oak board 0.75" thickness.

TG Forstner bit produced a through hole in the test board in 22.56 seconds with a 30 lbs. force.

TG Forstner bit maximum through hole speed was 3.53 seconds.

Wolfcraft Forstner bit produced a through hole in the test board in 48.50 seconds with a 30 lbs. force.

Wolfcraft Forstner bit maximum through hole speed was 6.30 seconds.

Summary Of Test Results: “Continued”

Forstner and Spade Bits: Curved Cut Ability:

Both TG Forstner and Spade bits were able to bore a 90 deg. curved through hole in a 4” X 4” wooden post.

Drill Bits: Slippage Test:

Test material: Stainless steel sheet 0.025” thickness.

Product	Average Recorded Slippage (inches)
TG KIK	0.057
TG HSS	0.094
Hitachi Black Shield	0.083
Hitachi Black Gold	0.101

Drill Bits: Exit Hole Burr Test:

Test material: Stainless steel sheet 0.02” thickness.

The Hitachi Black Gold produced an elongated hole with moderate burring at the exit.

The Hitachi Black Shield produced a consistently round hole with significant burring at the exit.

The TG HSS produced a consistently round hole with minor burring at the exit.

The TG KIK produced a consistently round hole with minor burring at the exit

Summary Of Test Results: “Continued”

Drill Bits: Consistent Through Hole Test – Steel Plate:

The TG KIK produced a significantly more smooth and consistent through hole than the Hitachi Black Shield.

Drill Bits: Cutting Time in Acrylic Test:

Test material: Acrylic plate 0.70” thickness.

TG KIK produced a through hole in 1.42 seconds with 30 lbs. force

Hitachi Black Shield produced a through hole in 3.22 seconds with 30 lbs. force

DeWalt Brad Point produced a through hole in 11.16 seconds with 30 lbs. force

Forstner Bits: Cutting Ability Test – Acrylic:

Test material: Acrylic plate 0.70” thickness.

Both the TG Forstner and TG spade bits were able to satisfactorily bore into the acrylic test plate.

Spade Bits: Cutting Ability Test – Brass:

Test material: Brass sheet 0.016” thickness.

The TG spade bit was able to cut a round section from the brass test plate.

Metallurgical Examination Test Results:

The first group of samples: Microhardness test results shows TG sample to be approximately 63 Rc in hardness where the Hitachi samples range from 59 to 66 Rc. It is our opinion that 63 Rc is more adequate for better performance as it is not too low such as 59 Rc where it can wear fast and not too hard such as 66 Rc where it can be brittle.

The Hitachi samples also showed signs of abrasive wear and some burning on the cutting edge where the TG sample showed no sign of wear or burning.

The coating thickness of the first group of samples was un affected, however, in the location where burning took place the Hitachi sample showed some breaking up of the coating while the TG sample remained un affected. The thickness of the coating in the Hitachi samples varied from 0.0002" to 0.0004" while the TG sample was at 0.0002" thick.

The microstructure in both sample appeared to be hardened tempered martensite with un dissolved distributed carbides indicating some type of tool steel used in the raw material. Sample number 1 Hitachi contained partial decarburization at the surface attributed to either lack of adequate heat treat or severe burning during testing of the region that was inspected.

The second group of samples for metallurgical testing consisted of two drill bits identified as 17/64 competitor samples and TG sample. The competitor's samples contained significantly higher hardness than the TG sample. The difference was about 6 Rc points which again make the competitor's samples more brittle and with some pressure during use may cause the bit to chip and burn as was the case here.

Clearly the competitor's bit using the same application contained significantly more burning and material roll over at the cutting edge and in the flutes than the TG sample, see figures 16 through 20. The microstructures were similar in that the matrix consisted of tempered martensite. The TG microstructure was more uniform and un affected after the drill test while the competitor's sample contained some signs of temper back condition and burning in the structure as a result of the testing.

The third group of samples were similar in wear after testing. The main difference was in hardness where the TG sample was approximately 5 Rc points higher (mid 50's RC). This hardness is not considered brittle as the brittle range starts around 63 Rc and higher.

Conclusions:

Based on all mechanical and metallurgical testing conducted in this study it is our opinion that TG tools tested in this project are superior in performance and endurance to the competitor's tools. Furthermore, TG samples exhibited more original conditions after testing than did the competitor's samples where burning and damage to the competitor's samples was more significant than the TG samples. This is significant to the tool life where metallurgical wear analysis prove TG tools to be in the order of and estimated two (2) times the life of the competitor's tools.

TG KIK,

1. Minor slippage or approximately 20% overall less slip when compared to Hitachi Black drill bit
2. Exceptional roundness and clean entry or greater than 50% cleaner entry when compared to Hitachi Black drill bit
3. No burr remained on edges of holes when compared to Hitachi Black drill bit which contained significant amount of burrs
4. No cracking drilling Acrylic, 150% faster when compared to Hitachi Black drill bit, 690% faster than Dewalt brad Point
5. Approximately 100% faster when compared to Dewalt brad Point and 40% faster when compared to Hitachi Black drill bit in wood

KIK Spade Bit,

1. Able to drill plastic including Acrylic
2. Able to drill none ferrous sheet metal, clean entry and no burr
3. able to bore 90 deg. curved path

KIK Forstner,

1. Approximately 100% Faster when compared to Wolfcraft Forstner
2. Clean entry, clean bottom, cleaner exit hole via Wolfcraft Forstner
3. Able to bore 90 deg. curved path

KIK HS Drill Bit,

1. Minor slippage or approximately 20% overall less slip when compared to Hitachi Black drill bit
2. Exceptional roundness, smoother path, and greater than 50% cleaner entry when compared to Hitachi Black drill bit
3. No burr remained on edges of holes when compared to Hitachi Black drill bit which contained significant amount of burrs

Important Statements

- The information in this metallurgical report is intended for the use of ATRONA's client and **may not be published or reproduced** except in full without ATRONA's expressed consent.
- The information and test results provided in this metallurgical report is representative of the components tested for this work, and does not extend to the lot or batch from which the tested components were drawn.
- ATRONA accepts no responsibility or liability for results due to non-representative test items, improper sampling, insufficient testing or misinformation.
- It is ATRONA's Policy to retain tested samples for 30 days. Please advise us within the 30-days time frame if you wish us to retain samples longer.

Please note that any stated discussion, comments, conclusions above are strictly the author's professional opinion based on results of testing requested or performed by ATRONA and /or its approved sub-contractors. This report certifies that test results provided are same as those contained in ATRONA's records. Some information provided in this report was furnished by the customer and is listed in this report for reference only. The information in this metallurgical report is intended for the use of ATRONA's clients and **may not be published or reproduced** except in full without ATRONA's expressed consent. The information and test results provided in this metallurgical report is representative of the components tested for this work, and does not extend to the lot or batch from which the tested components were drawn. ATRONA accepts no responsibility or liability for results due to non-representative test items, improper sampling, insufficient testing or misinformation. It is ATRONA's policy to retain samples tested for 30 days from report date, please advise us within the 30 day time frame if you wish us to retain test samples. All microstructure evaluations, comments, conclusions, and discussions are reported based on our professional opinion or from information we received from our clients. Please let us know if you have any questions or need further analysis. Thank-You.