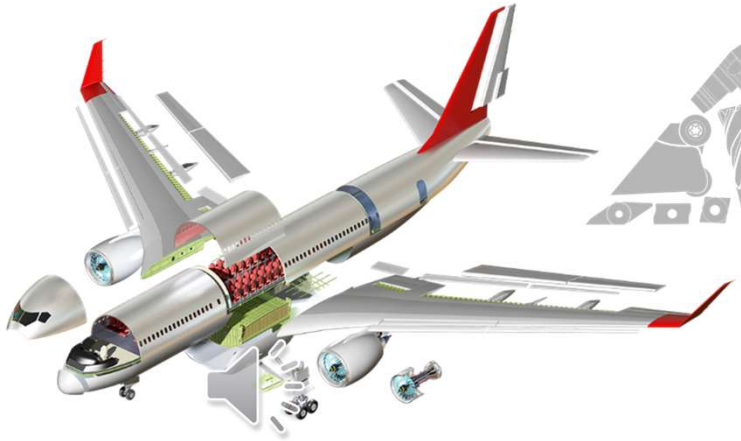
Strictly Confidential



Indexable inserts

HRSA turning

June 2020

Contact information

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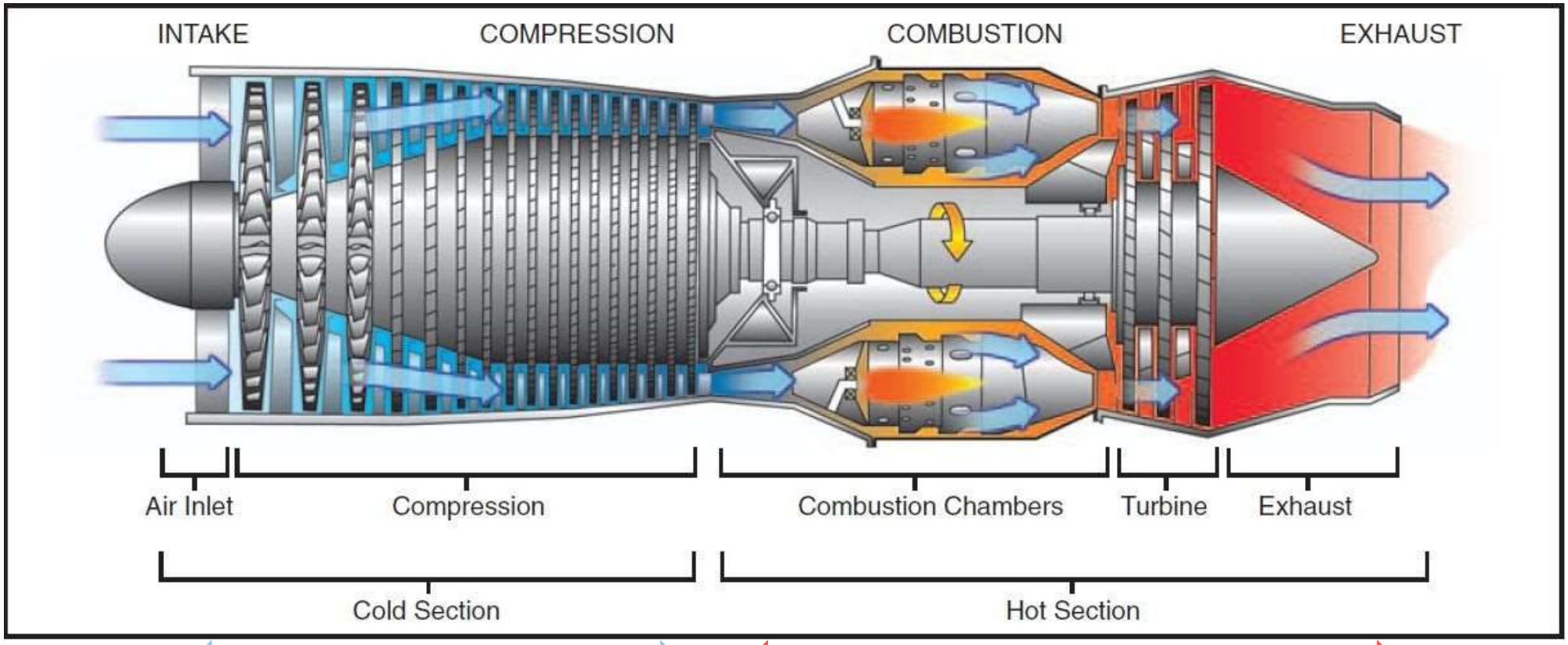
Aerospace Engine



Titanium, Composites, Aluminum

Inconel, Waspaloy, Rene, etc.

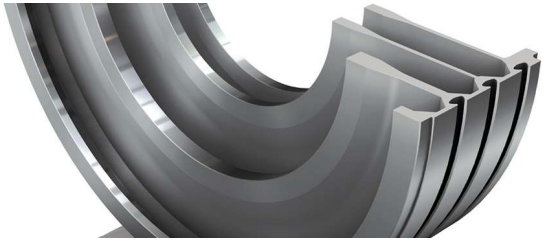
Engine Components

Shaft

Disc

Blisk/IBR

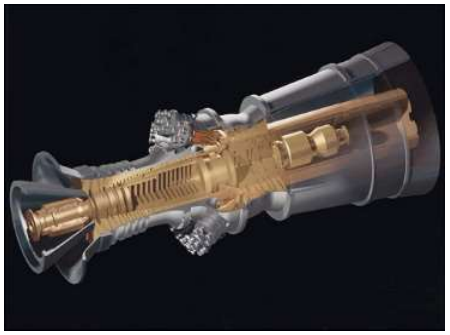
Combustion casing



Spools

Impeller

Other markets



Gas Turbines

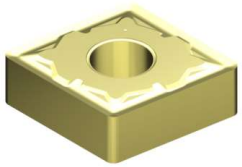
Steam Turbines

Medical

Oil

YG401 for HRSA materials

S



CNMG-SM

New Grade information

1) New PVD-Coating Technology

- Highly heat-resistant TiAlN structure realizes excellent flank, crater and notch wear resistance.
- Greatly improved film coating adhesion realizes excellent boundary defect resistance.
- Top coating layer provide smooth surface and lubricant effect

⇨ Extremely good adhesion for lower feed and lower D.O.C

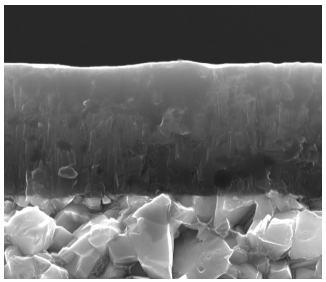
2) Ultra fine-grained carbide and balanced substrate

3) Improved wear resistance and surface finish by applying post treatment of low friction

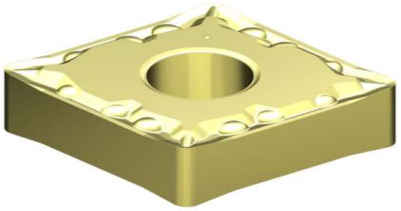
New Chip Breaker and Precision Ground (**GG Insert)

1) Periphery ground with sharpest edge line

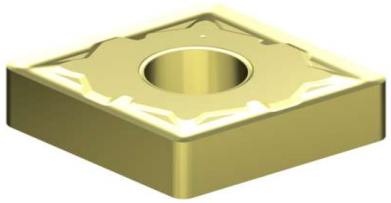
2) Excellent chip control in a variety of D.O.C and feed rates



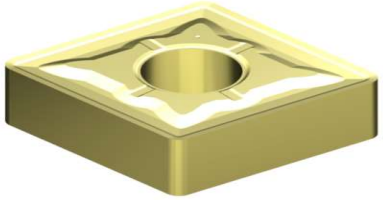
Chipbreakers for HRSA materials



CNGG120408-SF/CNGG432-SF
(For light cutting)



CNMG120408-SM/CNMG432-SM
(For medium cutting)

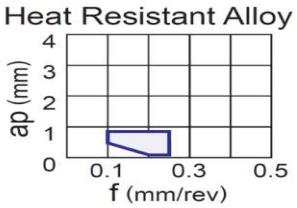


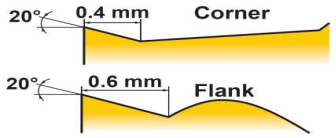
CNMG120408-SR/CNMG432-SR
(For roughing cutting)

SF

First recommendation for light cutting of difficult-to-cut materials

Enhanced chip disposal for depth of cut smaller than the corner R.

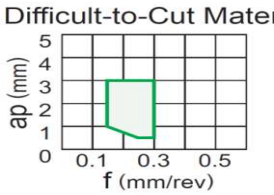


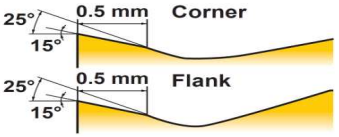


SM

First recommendation for medium cutting of difficult-to-cut materials

A large two-step rake corner creates chips without squeezing and entangled shapes.



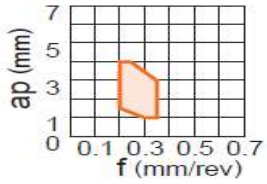


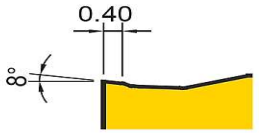
SR

First recommendation for rough cutting of difficult-to-cut materials.

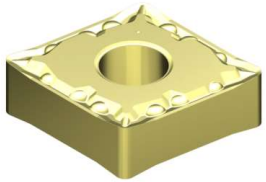
Increase the adhesion resistance, control to adhesion chipping and

boundary wear in low cutting speed





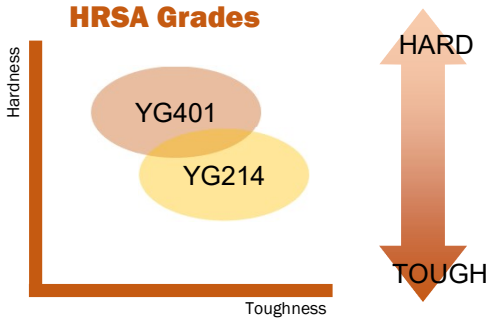
Why G tolerance only for -SF



CNGG120408-SF
CNGG432-SF

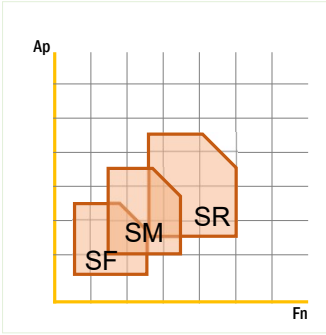
- G-tolerance reduces the risk of scrap when indexing
  - Cost of scrap extremely high due to high raw material cost and many machining hours before last stage machining
- Aerospace engine manufacturer demands G-tolerance for last stage machining
- Medical manufacturers typically demands G-tolerance inserts for finish pass

Turning HRSA



YG401 PVD S05-S15
For clean HRSA materials

YG214 PVD S30-S50
For skin and scale cuts at low speed



Chipbreakers

Types of HRSA

- Nickel based Super Alloys
  - 718+
  - IN100
  - ME16
  - RR1000
  - Inconel (625, 718)
  - Waspaloy
  - Rene (41, 88, 95, 103)
  - Udimet 720
  - GTD111
  - Haynes (242, 263)
  - Hasteloy (S, X)
- Cobalt based Super Alloys
  - Haynes (21, 25, 188, 556)
  - Stellite (6, 12, 20, 21, 25, F, 706, 712, Ultimet)
  - MAR-M (302, 509)
  - AiResist (213, 13)
- Iron based Super Alloys
  - A286
  - Greek Ascoloy
  - Incoloy (903, 907, 909)
  - AerMet 100 (technically Martensitic Stainless)

Types of HRSA and how they machine

Lamellar chip flow

- Ni based Superalloys
  - Aerospace engine components
  - Power Generation (Land based gas turbines)
  - Deep water Oil & Gas
  - Most common Inconel 718 (aged, 44-48HrC)

  - Dedicated PVD HRSA grades
  - Requires G tolerance or better for most finishing (aerospace)
  - Lamellar chipflow adding high stress on microgeometry requiring dedicated geometry
  - Highly susceptible to chemical wear (crater, notch), requires lead angles
  - Typical tool life 5-8 minutes
  - Low to Moderate speed
    - Inconel 718; 120-200SFM [35-60m]
    - Waspaloy; 100-180SFM [30-55m]

Types of HRSA and how they machine

Lamellar chip flow

- Co based Superalloys
  - Aerospace engine components
    - Hot section (blades, vanes) of turbine and combustor parts
  - Medical implants (ex. CoCr)
  - Most expensive of the ISO-S materials
  - Highest hot hardness
  - Haynes 188 most common

  - Dedicated PVD HRSA grades
  - Requires G tolerance or better for most finishing (aerospace)
  - Lamellar chipflow adding high stress on microgeometry requiring dedicated geometry. Select strongest possible geometry
  - Highly susceptible to chemical wear (crater, notch), requires lead angles
  - Typical tool life 5-6 minutes
  - Low to Moderate speed
    - Haynes 188; 100-180SFM [30-55m]

Types of HRSA and how they machine

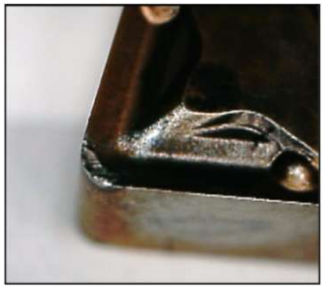
- Fe based Superalloys (aka Iron-Nickel)
  - Lowest elevated temperature strength of the ISO-S
  - Relatively inexpensive material
  - A286 most common

  - Typically PVD HRSA grades, but CVD stainless grades may be considered
  - Requires larger chip area due to continous chipflow
  - Highly susceptible to chemical wear (crater, notch), requires lead angles
  - Typical tool life 8-15 minutes
  - Low to Moderate speed
    - A286; 180-300SFM [55-90m]

Success stories

- Material: Inconel 718 non-aged, 36-38HrC
- Insert: CNMG120408-SM YG401/CNMG432-SM YG401
- Cutting data: 170SFM (52m), fn .008” (0.20mm), Ap .040” (1 mm)

5 minutes engagement

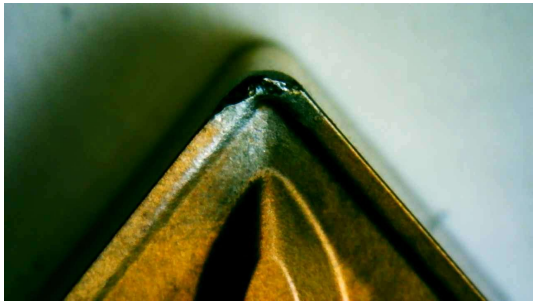


5 minutes engagement

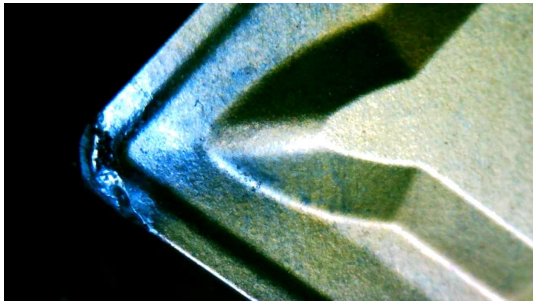
5 minutes engagement

Success stories

- Material: Waspaloy, forging scale
- Insert: CNMG120408-MR YG214/CNMG432-MR YG214
- Cutting data: 80SFM (24m), fn .008” (0.20mm), Ap .040” (1 mm)



5 minutes engagement



5 minutes engagement

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