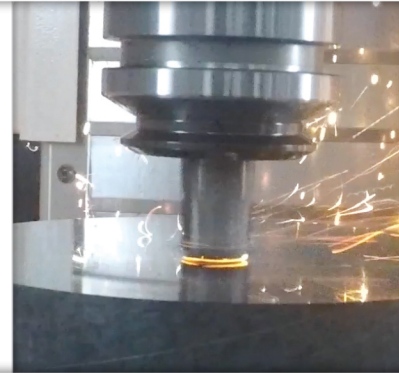
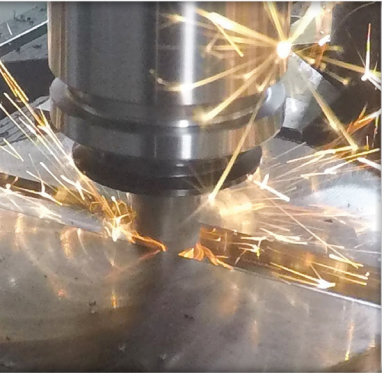




# **Greenleaf**<sup>®</sup>

*Tooling Solutions*



## **CERAMIC END MILLS**

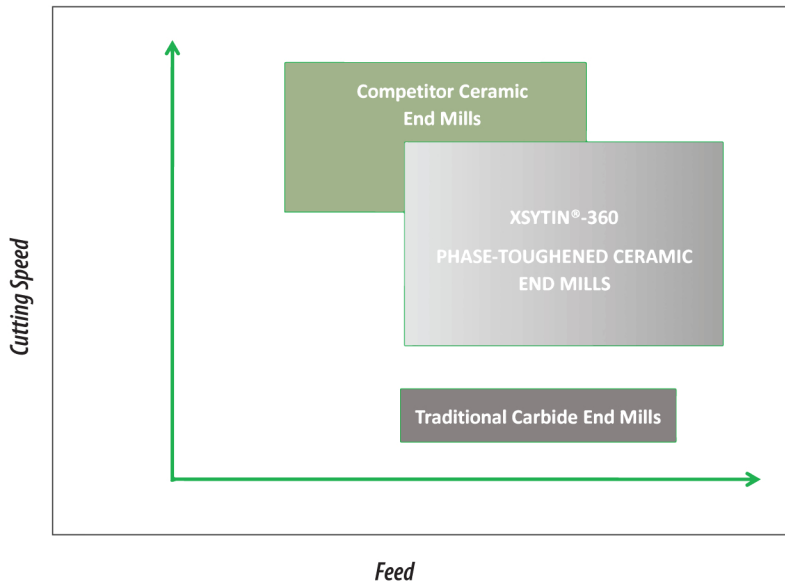
# Product Highlights

## FINALLY—A solid ceramic end mill that outperforms carbide!

XSYTIN®-360 ceramic end mills combine Greenleaf's phase-toughened XSYTIN®-1 substrate with a unique cutting geometry that offers ten times higher productivity and tremendous cost savings. The strength of the material allows the user to apply chip loads similar to solid carbide end mills with higher speeds common to ceramic machining. These new ceramic end mills provide customers with significant increases in productivity over current solid carbide or ceramic products.

## Capabilities

### Speeds and Feeds



- Capable of slotting, pocketing with ramping, and profiling applications maintaining heavy chip loads
- A very broad application range means numerous machining centers are capable of running these end mills
- Extremely versatile end mills with twice the feed rate capability and a much broader speed range!

## Materials

Proven performance in machining a variety of different materials:

- High-temperature alloys
- Hardened steels
- Ductile cast irons
- Compacted graphite iron (CGI)
- 3D-printed sintered high-temperature alloys

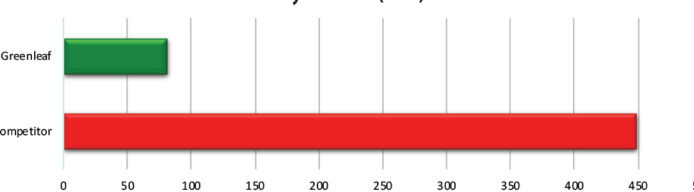




## Hardened 4150 Steel (53-55 HRC)

Competitor	Greenleaf
HP Carbide ~ .500" (12.7 mm) Diameter 5-Flute Variable Helix Speed: 275 SFM (83.8 m/min) Feed: 0.0022" IPT (.056 mm/tooth) Ap: 0.200" (5.08 mm)   Ae: .040" (1.02 mm)	XSYTIN®-360 ~ .500" (12.7 mm) Diameter 4-Flute Variable Helix Speed: 1500 SFM (457.2 m/min) Feed: 0.0028" IPT (.071 mm/tooth) Ap: 0.200" (5.08 mm)   Ae: .040" (1.02 mm)

Cycle Time (min)

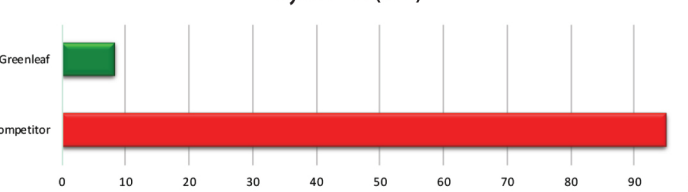


Cycle time reduction of over 6 hours in hardened steel!

## Inconel 718 (45 HRC)

Competitor	Greenleaf
HP Carbide ~ .500" (12.7 mm) Diameter 5-Flute Variable Helix Speed: 160 SFM (48.8 m/min) Feed: 0.0022" IPT (.056 mm/tooth) Ap: 0.200" (5.08 mm)   Ae: .050" (1.27 mm)	XSYTIN®-360 ~ .500" (12 mm) Diameter 4-Flute Variable Helix Speed: 1500 SFM (457.2 m/min) Feed: 0.0034" IPT (.086 mm/tooth) Ap: 0.200" (5.08 mm)   Ae: .050" (1.27 mm)

Cycle Time (min)

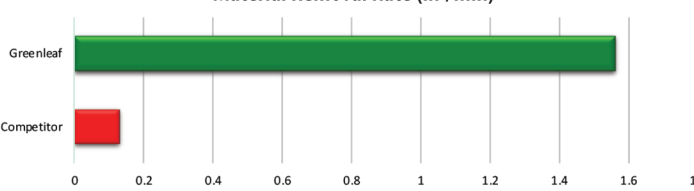


55% feed increase over carbide at 9X the cutting speed!

## Inconel 718 (45 HRC)

Competitor	Greenleaf
Carbide ~ .512" (14 mm) Diameter 3-Flute Conventional Speed: 49 SFM (14.9 m/min) Feed: 0.0014" IPT (.035 mm/tooth) Ap: 0.3937" (10 mm)   Ae: .512" (14 mm)	XSYTIN®-360 ~ .4724" (12 mm) Diameter 4-Flute Variable Helix Speed: 1500 SFM (457.2 m/min) Feed: 0.0034" IPT (.086 mm/tooth) Ap: 0.0945" (2.40 mm)   Ae: .4724" (12 mm)

Material Removal Rate (in<sup>3</sup>/min)

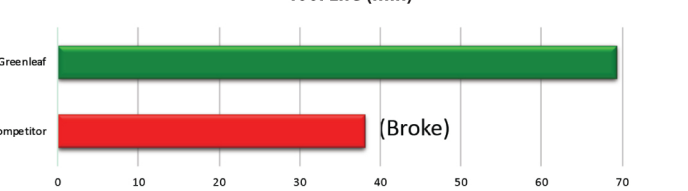


91% cycle time reduction with 12X the material removal rate!

## Hardened 4150 Steel (53-55 HRC)

Competitor	Greenleaf
Sialon Ceramic ~ .375" (9.5 mm) Diameter 4-Flute Conventional Speed: 1500 SFM (457.2 m/min) Feed: 0.0024" IPT (.061 mm/tooth) Ap: 0.150" (3.81 mm)   Ae: .030" (0.76 mm)	XSYTIN®-360 ~ .375" (9.52 mm) Diameter 4-Flute Variable Helix Speed: 1500 SFM (457.2 m/min) Feed: 0.0024" IPT (.061 mm/tooth) Ap: 0.150" (3.81 mm)   Ae: .030" (0.76 mm)

Tool Life (min)



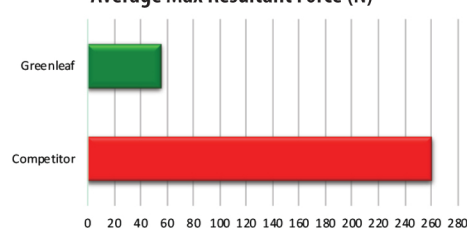
82% increase in tool life and still cutting strong!

## Compacted Graphite Iron (CGI)

### Competitor / Greenleaf Parameters

Ceramic ~ .375" (9.52 mm) Diameter  
4-Flute Conventional  
Speed: 1500 SFM (457.2 m/min)  
Feed: 0.0024" IPT (.061 mm/tooth)  
Ap: 0.060" (1.52 mm) | Ae: .375" (9.52 mm)

Slot Milling  
Average Max Resultant Force (N)

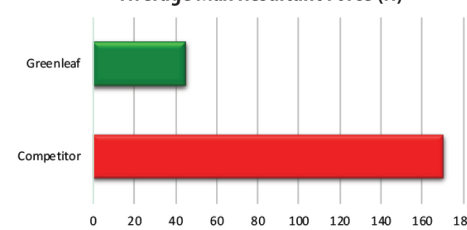


Reduced cutting forces by an average of 76% compared to competitor's ceramic when machined at identical parameters!

### Competitor / Greenleaf Parameters

XSYTIN®-360 ~ .375" (9.52 mm) Diameter  
4-Flute Variable Helix  
Speed: 1500 SFM (457.2 m/min)  
Feed: 0.0012" IPT (.030 mm/tooth)  
Ap: 0.056" (1.42 mm) | Ae: .375" (9.52 mm)

Helical Milling  
Average Max Resultant Force (N)



# Application Data

## Parameters – HRSA

Application	Speed – SFM (SMM)	*Feed – IPT (mm/t)	Ap – Axial DOC	Ae – Radial DOC	Average Chip Thickness – in. (mm)
Side Milling	1300-2000 (396-610)	0.0014-0.0044 (0,036-0,112)	<=0.5*D	<=0.1*D	0.001-0.0023 (0,028-0,058)
Slot Milling	1300-2000 (396-610)	0.0006-0.002 (0,0015-0,051)	<=0.2*D	D	0.001-0.0023 (0,028-0,058)

\*May be capable of higher feed rates, depending on application

## Parameters – Cast Iron, CGI, Hardened Steel

Application	Speed – SFM (SMM)	*Feed – IPT (mm/t)	Ap – Axial DOC	Ae – Radial DOC	Average Chip Thickness – in. (mm)
Side Milling	1300-2000 (396-610)	0.0012-0.0036 (0,036-0,091)	<=0.5*D	<=0.1*D	0.0009-0.0017 (0,023-0,043)
Slot Milling	1300-2000 (396-610)	0.0005-0.0016 (0,013-0,041)	<=0.2*D	D	0.0009-0.0017 (0,023-0,043)

\*May be capable of higher feed rates, depending on application

## Recommendations for Best Performance

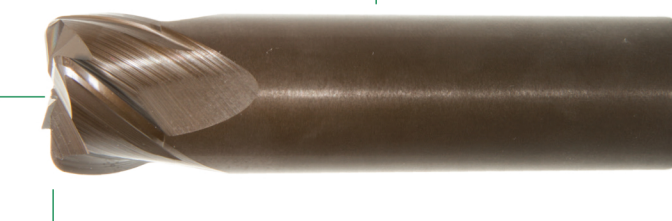
- Workpiece fixturing must be rigid to reduce vibrations
- Use of precision milling chucks (hydraulic/shrink-fit) required
- Reduce tool overhang as application allows
- Tool path should be programmed to maintain recommended average chip thickness with continuous engagement
- Ramping process for pocketing may be applied with angle of inclination less than 3° and reduction of feed by 50%
- Do **NOT** use coolant
- Use of air blast is acceptable to aid in chip removal
- **Do NOT remove built-up edge from tooling when machining HRSA materials**



# Product Information

XSYTIN®-1 ceramic material provides ultra-high strength and wear resistance at extreme feed rates.

Unique flute design minimizes cutting forces, which reduces vibrations and optimizes tool life.



Overall length provides the option for regrind.

## Stock Availability

### XSYTIN®-360: Imperial

Part Number	Dc (cutting dia. inch)	Number of Flutes	Corder Radius (inch)	Ds (shank dia. inch)	Shank Tolerance	Ap Max (inch)	OAL (inch)
31E4X0252	0.3125	4	0.031	0.3125	h6	0.2500	2.250
37E4X0313	0.3750	4	0.047	0.3750	h6	0.3125	2.500
50E4X0374	0.5000	4	0.063	0.5000	h6	0.3750	2.750
62E4X0445	0.6250	4	0.078	0.6250	h6	0.4375	3.000
75E4X0506	0.7500	4	0.094	0.7500	h6	0.5000	3.250

### XSYTIN®-360: Metric

Part Number	Dc (cutting dia. mm)	Number of Flutes	Corder Radius (mm)	Ds (shank dia. mm)	Shank Tolerance	Ap Max (mm)	OAL (mm)
DME4X0610	8.00	4	1.00	8.00	h6	6.00	60.00
EME4X0712	10.00	4	1.25	10.00	h6	7.50	65.00
FME4X0915	12.00	4	1.50	12.00	h6	9.00	70.00
GME4X1117	16.00	4	1.75	16.00	h6	10.50	75.00
HME4X1220	20.00	4	2.00	20.00	h6	12.00	80.00



See the XSYTIN®-360 end mills in action on Greenleaf Corporation's YouTube channel.







Greenleaf Corporation is a leading supplier of industrial cutting tools, specializing in the manufacture of high-performance tungsten carbide and ceramic grade inserts and innovative tool-holding systems. Greenleaf continues to build on 75 years of innovation and the legacy established by its founder Walter J. Greenleaf, Sr., which centers on supplying customers with productive solutions to every metal-cutting situation.

Discover more at: [www.greenleafcorporation.com](http://www.greenleafcorporation.com)

 ***Greenleaf Corporation is a world leader in ceramic cutting tools!***



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