



# DEFENSE

## Tungsten Solutions for Defense Applications

Small & Medium Tungsten Carbide (WC) Armor-Piercing Cores

Medium & Large Tungsten Heavy Alloy (WHA) Armor-Piercing Penetrators

Subprojectiles/Fragmentation Devices

Powders

KennaShield™ Light and Improved Armor Protection

Tooling, Wear Protection, and Counterweights (Stabilizer & Ballast)





General Engineering Solutions



Oil and Gas Wear Solutions



Mining Wear Solutions



Construction Wear Solutions



Process Industries Wear Solutions

## We Can Solve Your Most Challenging Problems

In addition to our general engineering tooling capabilities, Kennametal is a global supplier of solutions for wear, heat, and corrosion problems; a world-class manufacturer of components; and a service provider to a wide range of industries. For years, we have helped customers in the oil and gas, construction, mining, and process industries. This broad experience lends itself well to defense applications where precision and quality are key.

Kennametal's commitment to providing solutions for the most demanding applications is unparalleled. With a long history of helping our customers achieve success and a tradition of exceeding their expectations, Kennametal is a US-owned, vertically integrated tungsten manufacturer.

**By matching our advanced material solutions and technologies to your applications, we can help you solve your biggest challenges. Building on our vast experience in a variety of markets, we can provide our defense customers unique, customized solutions and a long-term, reliable partnership.**

**TUNGSTEN SOLUTIONS FOR DEFENSE APPLICATIONS**

Our goal is to deliver top performance and quality. By leveraging our many years of experience providing solutions for difficult applications and our expertise in the material sciences, Kennametal maintains a unique ability to offer superior defense solutions. Through value-added partnerships, we provide our customers with battlefield over-match in penetration, fragmentation, and armor protection. We aren't setting the performance standard for the defense industry — we are resetting it even higher.

Contact us today and we'll find the right solution for you.

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## Count on Kennametal for High-Performance Wear Solutions

### MATERIAL SCIENCE EXPERTISE

Kennametal’s wear solutions begin with our material science expertise. Being a producer and supplier of raw materials enables us to maintain critical control over our materials.

Our primary portfolio of materials includes tungsten carbide, cobalt, nickel, and other specialty additives. We combine these materials to create unique formulas and grades to solve specific challenges.

### PROVEN MANUFACTURING METHODS

Finding the right materials for your application is the first step, but you also need proven manufacturing methods to solve complex wear issues.

Kennametal’s network of global manufacturing operations enables us to take our quality materials and turn them into products and solutions while maintaining the highest level of quality from the inside out.

### BUILDING ON ADDITIVE MANUFACTURING

Metal additive manufacturing processes — metal 3D printing — represent the next generation in design freedom, manufacture cost reduction, and supply chain optimization. These proven processes are being leveraged across multiple industries and applications to quickly and efficiently develop and deploy high-performing parts.

Kennametal develops materials specific to additive manufacturing, offering additive metal powder feedstock materials and finished parts. Our gas atomization powder production capabilities supply cobalt, nickel, and iron powders optimized for specific additive manufacturing processes. Kennametal’s expertise in sintering and post printing processes provides custom solutions in both tungsten carbide and CoCr6 materials.

### AN UNDERSTANDING OF YOUR UNIQUE WEAR ISSUES

Quality materials and proven manufacturing methods are only part of the equation. At Kennametal, we are aware that our expertise is only beneficial if we truly understand your challenge.

Through close partnerships with our customers, we design, develop, and manufacture solutions that deliver exceptional value throughout the lifecycle of the components. At Kennametal, we leverage our extensive knowledge of materials technologies and manufacturing methods to develop your unique solution.



## Kennametal Wear Protection Solutions Are Made from the Right Materials

		MATERIAL SYSTEMS OVERVIEW			
		Tungsten Carbide	KenCast™	Conforma Clad™	CoCr6
Wear Mechanism:	Abrasion Resistance	•••	•	••	••
	Corrosion Resistance	••	•	••	•••
	Erosion Resistance	•••		••	••
	High-Temp Resistance	••	••	•••	•••
	Impact Resistance	••	•••	•	•••
Material Form:	Casting		X		X
	Coating	X		X	X
	Powder	X			X
	Sintered	X			X
	Wrought				X
Manufacturing Method:	Powder Compaction	X			X
	Green Forming	X			
	Casting		X		X
	Machining/Grinding	X		X	X
	Brazing/Assembly	X		X	
	Welding		X	X	X

### Tungsten Carbide

Kennametal has been manufacturing tungsten carbide products since our inception.

Cemented tungsten carbide possesses unique engineering properties that makes it ideal for countless industrial applications. In addition to being more durable, it is often more economical than other materials. Tungsten carbide is used for parts that must withstand extremes of wear, including deflection, deformation, abrasion, erosion, galling, and corrosion.

Unlike some carbide manufacturers, Kennametal produces its own powders, ensuring the highest quality tungsten carbide from start to finish.

### KenCast

KenCast™ is composed of tungsten carbide particles that have been metallurgically bonded to air-hardened steel. The result is a tough, durable, and extremely wear-resistant material.

Carbide granules give KenCast exceptionally long-lasting protection. Various-sized tungsten carbide particles are blended to create a precise combination of carbide protection for your specific application. Both standard and custom shapes and geometries can be produced.

### Conforma Clad

Conforma Clad™ incorporates two industry workhorse materials — tungsten carbide and CoCr6 cobalt-based alloys — into our unique cloth-based and Ultraflex™ slurry-based processes. This enables us to provide superior wear-resistant claddings for a wide variety of substrate materials and geometries in a broad range of industries and applications.

### CoCr6 Materials

Our CoCr6 family of alloys has a long and distinguished history of delivering in the toughest of applications. Since its inception in 1912, the family of CoCr6 alloys has grown to more than 300 unique solutions, including known brands such as Tribaloy™, Nistelle™, and others.

CoCr6 alloys are available as consumable powders, hardfacing materials and equipment, and wrought bar and sheet. Through complex casting and finished machined components, our engineers will work with you to provide the solution that best fits your need.

# Kennametal at a Glance:

## SOLVING CUSTOMER CHALLENGES AROUND THE WORLD

As a world leader in tooling and wear-resistant solutions, Kennametal is a US-owned, vertically integrated tungsten manufacturer.

- 8,600+ Employees
- Serving 80,000+ customers
- Operating in 60+ countries
- Founded in 1938
- 1,725 total active patents worldwide

### Certifications Include:

- Quality Management ISO 9001
- Aerospace Quality Management AS9100
- Environmental Management ISO 14001
- Energy Management ISO 15001



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**International HQ:**  
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**Kennametal Infrastructure GmbH  
Mistelgau, Germany**



**HQ India:**  
Bangalore, India



**HQ Asia-Pacific:**  
Singapore



*Leveraging our broad portfolio of materials and vast experience in defense, Kennametal is uniquely qualified to serve as your long-term partner. We provide customized solutions for a variety of defense applications in which quality is maintained while costs are kept in check.*

# When strength, accuracy, or penetration is the goal, Kennametal has your solution.

## Small & Medium WC AP Cores

### Kennametal Tungsten Carbide Cores

- High dimensional and weight accuracy
- Consistent quality level
- High volume capabilities
- Cobalt-free material on request

### Typical characteristics:

- Density 14 g/cm<sup>3</sup>
- Hardness HV30 1300 / HRC 74
- Bend strength 3000 MPa

Material properties can be customized to specific requirements.



### Calibers

4.7mm | 5.56mm | 6.5mm | 6.8mm | 7.62mm | 9mm | 12.7mm | 20mm | 25mm  
 .300" | .308" | .338" | .375" | .50"

### Typical Penetration Performance



**5.56mm WC AP Core**

- 12mm armor RHA steel
- Target distance 100m
- Impact angle 0° NATO



**7.62mm WC AP Core**

- 18mm RHA steel at 100m, 7mm RHA Steel at 500m
- Target distance 100m and 500m
- Impact angle 0° NATO



**.338" WC AP Core**

- 12mm steel HB 500 at 600m
- Target distance 600m
- Impact angle 0° NATO



## Medium & Large WHA AP Penetrators



### Kennametal KE Ammunition Penetrators

- Tungsten Heavy Alloy
- Suited for KE ammunition
- L/D ratios up to 20
- Cobalt-free material on request
- Swaging and heat treatment competency
- Sub-assembly capabilities

### Typical characteristics:

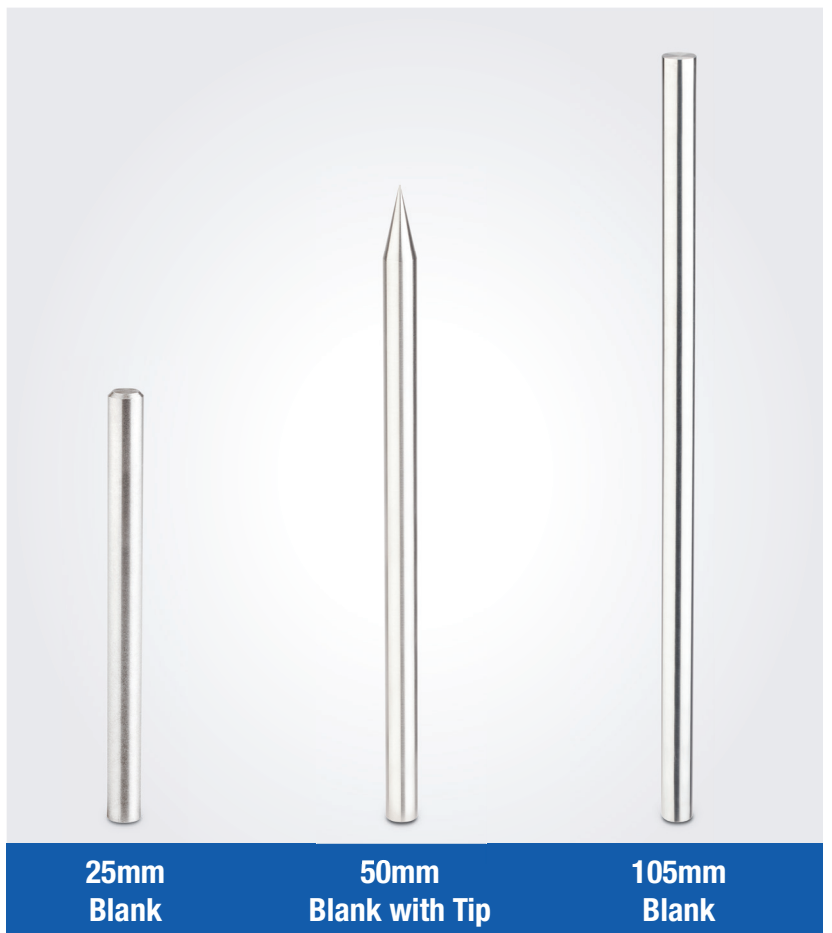
Density 17.3–18.6 g/cm<sup>3</sup>

Tensile strength/UTS 800–1650 MPa\*

Yield strength 800–1620 MPa\*

Elongation 20%–6%\*

\*Swaged and heat treated.  
Material properties can be customized  
to specific requirements.



25mm  
Blank

50mm  
Blank with Tip

105mm  
Blank

### Medium Calibers

20mm | 25mm | 30mm | 35mm | 40mm | 50mm

### Large Calibers

90 to 125mm

## Subprojectiles/Fragmentation Devices

Subprojectiles/fragmentation devices are available in a variety of dimensions and geometries — globe, cube, cylinder, and custom.



## Powders

Kennametal powders provide solutions for applications needing high-temperature and erosive-wear protection. Kennametal supplies tungsten powders for high-density rocket propellants, rocket propellant exhaust nozzles, and inert fuze function delays in artillery applications.



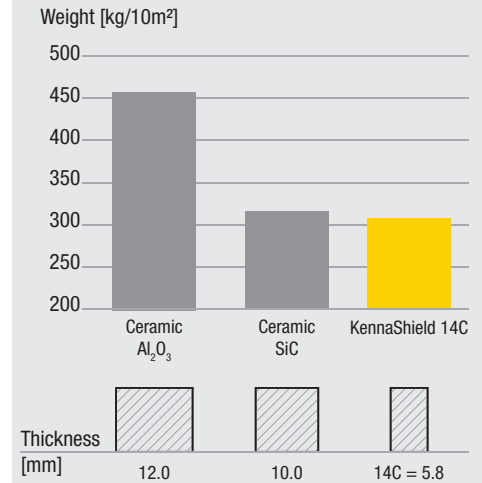


## Light and Improved Armor Protection

- Successfully qualified at VTU (CZ) and IABG (GER) Ballistic Laboratory
  - Official Multi-Hit pattern at -32° C and +49° C
  - Additional “seam gap test”
  - Certified Test Report with 7.62 x 51mm (AP8 WC core) @ 930m/s @ 15m distance
- Provides multi-platform solutions up to STANAG 4569 multi-hit for Level 3, Level 4, Level 5 and Level 6
- Additional armor material solutions available in accordance with customer specifications



### KennaShield vs. Ceramics



- Based on 8mm ARMOX 500T vehicle basic armor
- On average, protected surface of 10 sqm/ vehicle STANAG 4569 Level 1 to 3

## Tooling, Wear Protection, and Counterweights (Stabilizer & Ballast)

Kennametal also produces a wide variety of tungsten carbide components for high wear applications. These high wear applications range from using tungsten carbide to replace steel components on military vehicles to replacing steel punches and dies for manufacturing tooling.

By analyzing your drawings to accurately assess your quality and tolerance requirements as well as cost of production, we can provide the right solution for your very specific requirements.

Counterweights, made with our tungsten heavy alloy, provide increased performance levels. However, a full solution requires more than the right material.



## Kennametal: A Global Leader for Defense Solutions.

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