

# PLASMA TRANSFERRED ARC

## PTA STARWELD™



# Professional surfacing with STARWELD™

For more than 100 years, Kennametal Stellite™ has been the industry's partner of choice in wear solutions. Now Kennametal Stellite is proud to bring you the most competitive portfolio of professional surfacing solutions with our state-of-the-art coating equipment and component surfacing technologies.

Our STARWELD PTA coating systems provide a versatile method of depositing high-quality hardfacing claddings at low costs. The portfolio of equipment includes everything from manual hand-held surfacing solutions to fully customized multi-axis/robot manipulation and automation.

## Industries Served

Kennametal Stellite STARWELD systems are prominently featured as the equipment of choice in a variety of industries and applications, including:

- **Aerospace**
- **Oil & Gas**
- **Automotive**
- **Power Generation**
- **Nuclear**
- **Lumber**
- **Processing Industries**



# STARWELD PTA

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## Plasma Transferred Arc (PTA)

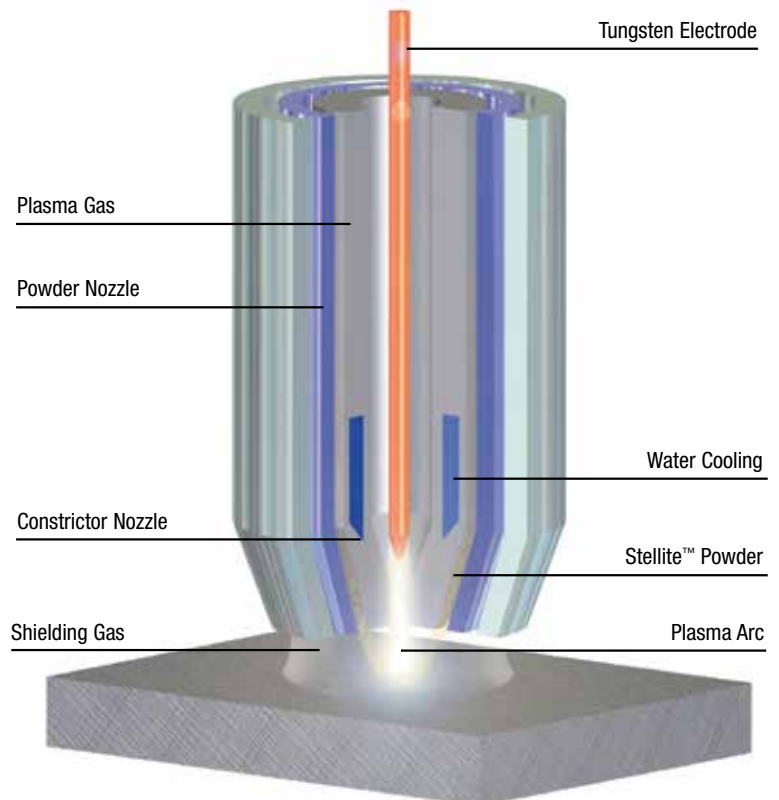
PTA hardfacing is a versatile method of depositing high-quality metallurgically bonded deposits on relatively low-cost surfaces. A wide variety of alloys, composites, and carbides can be deposited on a multitude of substrate materials and geometries to achieve desirable properties, such as mechanical strength, wear and corrosion resistance, and creep.

Typical PTA operations begin with the striking of the pilot arc, followed by the initiation of the transfer arc, and the subsequent deposition of material.

The pilot arc is struck between the constrictor nozzle and the tungsten electrode, using a high-frequency generator, and creates a low-resistance “pathway” from the electrode tip to the workpiece.

The transfer (plasma) arc, when ignited, follows this low-resistance pathway to the workpiece, creating a weld pool at the substrate. Deposition occurs when the metallic powder is carried through the plasma arc, where it is melted and deposited into the weld pool.

Kennametal Stellite™ STARWELD PTA cladding systems deposit metallurgically bonded, fully-dense coatings, which deliver outstanding performance in some of the most aggressive wear and corrosive environments.



# Applications

For more than 100 years, Kennametal Stellite™ has worked with the leading companies in a variety of industrial segments, including aerospace, oil & gas, automotive, nuclear, and processing industries. This has allowed us to improve our offering through continuous alloy and applications technology development.



## Automotive & Diesel

As automotive engines continue to push the envelope in performance and efficiency, material selection and implementation are of utmost importance. Kennametal Stellite PTA systems remain at the forefront of engine valve performance and service life. Our equipment and materials are routinely used on the sealing surfaces of engine valves to boost fuel efficiency and engine life.

## Petrochemical/Chemical

The Kennametal Stellite portfolio can be found throughout the chemical processing industry where routine weld overlays of Stellite, NISTELLE™, Deloro™, and TRIBALOY™ materials are utilized to mitigate wear and corrosion. Specific PTA processes are developed to clad a variety of components, including nozzles, thermowells, valve trims, valve bodies, stop valves, and pump components, thereby increasing component life and reliability.

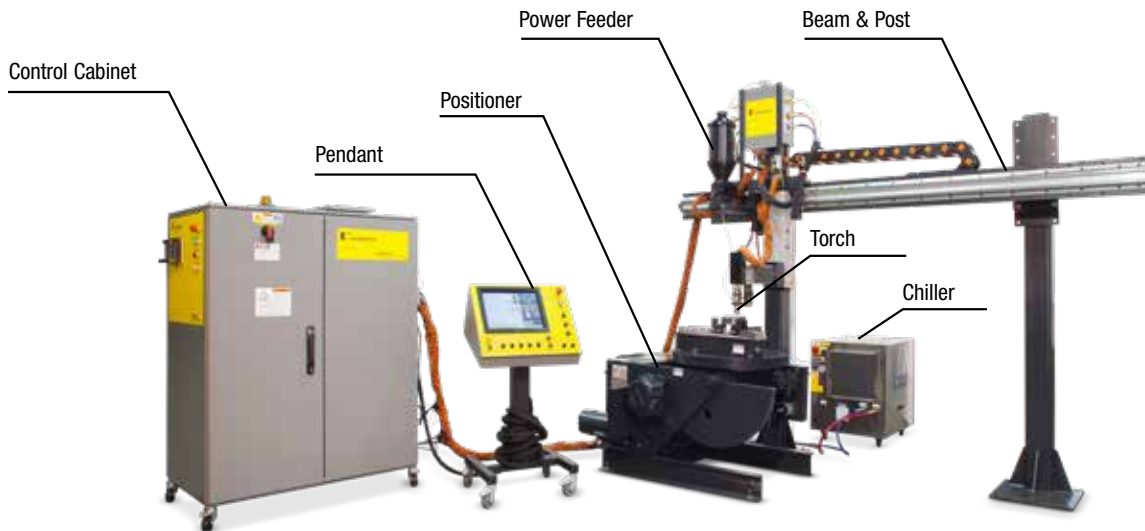


## Oil & Gas

Kennametal and Kennametal Stellite are involved in virtually all aspects of the upstream oil & gas industry. Our PTA systems are used to create high performance/low cost wear surfaces on a variety of components and parts, including: drill bits, pumps, chokes, valves, artificial lift equipment, piping and tubing, and stabilizers (to name a few). Our equipment's inherent automation and efficiency ensure operating costs are kept to a minimum.

## STARWELD™ 400 PTA Systems

The STARWELD 400 welding system is the most versatile PTA system on the market today. This PTA system uses the latest technology to provide a highly consistent, reliable, easy-to-use, and cost-effective solution for cladding and coating operations.



*STARWELD 400 with 10' beam & post and tilt/turn positioner*

The 400 system can be successfully integrated with a wide range of part and torch manipulation equipment, including standard post and beams, robot positioners, or in some cases, existing PTA manipulation platforms.

The STARWELD 400 system delivers fully automatic weld sequences, such as:

- **Circular step-over:** Diameters can be hardfaced in a series of passes or beads. After each pass, the torch is moved over to a predetermined position when the next bead is started. The step-over distance, speed, and number of steps are programmable.
- **Spiral welding:** A method of hardfacing on a diameter where the rotational speed and torch movement is coordinated to achieve coverage in the form of a continuous spiral.
- **Linear welding:** One or more linear beads can be programmed to achieve straight line beads. The X and Y axis can also be coordinated to provide square or rectangular welding patterns.

## STARWELD™ 400 • Manipulators and Positioners

The Kennametal STARWELD 400 can be supplied with a variety of torch manipulators and part positioning devices for semi-automatic welding. Our engineers will help you select from a wide range of options to ensure the optimal configuration for your workpiece and application is achieved.



*STARWELD 400 with 20' beam and carriage*



*STARWELD 400 with skid-mounted positioner*

### Beam and Carriage Systems

For parts with long lengths, weld carriages are most appropriate. Kennametal engineers can integrate these carriages with lathe-type positioners or combine with tilting positioners for increased versatility.

### Robotic Systems

For the ultimate in flexibility and automation, Kennametal Stellite™ engineers can assist in the integration of the STARWELD 400 PTA units with robotic cells. This will allow you to achieve complete control of the part positioning and weld processing directly through a robot controller.



*STARWELD 400 with robot positioner*

## STARWELD™ 400 • Torches

Kennametal Stellite ingenuity and passion for PTA performance is showcased in our portfolio of high-quality torches. Our portfolio of torches is designed with efficiency and flexibility in mind. This allows users to optimize tools for their specific application.



### Excalibur™ II & Excalibur Heavy Duty II

Excalibur II torch is the pinnacle of PTA welding performance and technology. Its innovative design allows high efficiency hardfacing operations with low maintenance and operating costs.

Excalibur II torch features include:

- High-efficiency nozzles with a choice of multi-powder ports. Powder efficiency measured at 99.5% recovery with a 1/8" (3.2mm) nozzle.
- Two powder ports.
- 12" electrodes in 1/8" and 3/16" diameters.
- Self-centering electrode.
- Fully sealed internal powder feed to eliminate losses and contamination.
- Replaceable torch parts.
- Fully machined construction to precise standards.
- Quick-change nozzles do not require securing screws.



***Kennametal maintains a wide portfolio of PTA torches for a variety of applications. Ask our engineers which one is right for you.***

## Model 600

The Model 600 torch can be installed on almost any STARWELD PTA system. This general purpose, water-cooled, hardfacing torch is used for numerous applications. The Model 600 is only about 1.5" in diameter, making it easy to get into tight spots:

- Orifice diameter available in 3/32", 1/8", 5/32", and 3/16".
- Better arc control.
- Connection points that are color-coded to facilitate installation.
- Removable powder tubes.
- Self-centering electrode.
- Extended nozzle for hard-to-reach corner areas.



## Model 200 ID

The Model 200 ID torch is a low profile PTA torch that will coat internal bore surfaces down to 3-1/2" diameters. Its nozzle is designed to provide efficient cooling for applications requiring preheat as high as 800° F.

- Available in 12", 24", and 36" lengths.
- Small profile (1-3/4" diameter x 2" high), allowing surfacing of internal bores as small as 3-1/2" in diameter.
- Designed for rapid heat dissipation, allowing for maximum nozzle life.
- Precise, reliable, and efficient (up to 95%) material delivery using a 4-port powder injection system.
- Complete encapsulation of the torch's gas and water service tubes.
- Deposition rates up to 4 lbs/hr at 150A continuous cycle.





## MicroStar™ Handheld PTA Systems

Kennametal Stellite™ MicroStar tools are a self contained, hand-held PTA welding system. MicroStar tools are ideal for a wide range of unique hardfacing applications.

These systems are designed to meet the various repairing and hardfacing demands for a multitude of applications. Each MicroStar unit is engineered as a portable and robust system with hand-held deposition capability.



## MicroStar HPH™ Handheld Torches

The HPH 80 and HPH 150 torches are designed to be used with the STARWELD Microstar self contained, hand-held PTA welding system. Each are designed to be operated at different amperages, depending on your application.



*HPH 80 Torch*



*HPH 150 Torch*

	HPH 80	HPH 150
<b>Current Capacity</b>	80A	120A
<b>Pilot Current</b>	Max 15A	Max 20A
<b>Max Deposition</b>	3 lbs/hr	4 lbs/hr
<b>Weight</b>	5 oz	1lb

## ValveStar™ PTA Systems

The Kennametal ValveStar PTA setup is designed for the automatic PTA hardfacing of automotive engine valves. The valves are introduced into the welding area via a gravity chute. The valves are separated, aligned, and placed onto the rotary table by the handling system. The torch movement is manually adjusted in three axis and is pneumatically raised and lowered to facilitate loading of the valve on the rotary table. The valves are clamped pneumatically onto the water cooled rotary table. After welding, the valves are fed into a collection area.



### ValveStar PTA Setup

- 1 set PTA power source STARWELD PTA control box.
- 1 set powder feeding system PR-S 5.
- 1 set PTA torch Model 600.
- 1 set refrigerating unit LT 05.3-2 for cooling the PTA torch and rotary table.
- 1 set valve handling system.
- Complete welding cycle control.
- Electrical and pneumatic cables and hoses.
























## Stellite™ PTA Powders

With over 100 years of proven performance, Kennametal Stellite is known as the worldwide material solution for wear, heat, and corrosion applications. Through decades of engineering and optimization, Kennametal Stellite is proud to offer one of the most comprehensive portfolios of PTA powders on the market. Kennametal Stellite powders are produced under stringent quality standards at one of our ISO 9000/9001 certified facilities using the state-of-the-art in manufacturing technologies.

### Selection Table

	ALLOY	MECHANICAL WEAR	CORROSION	HIGH-OPERATING TEMPERATURE
<b>RESISTANCE</b>  Low  Satisfactory  Very Good  Excellent	Stellite			
	Deloro™			
	TRIBALOY™			
	NISTELLE™			
	Stelcar™			

## Stellite™ PTA Powders

Cobalt-based Stellite alloys are the most well-known and successful alloys in the world, with the best all-around properties. They combine excellent mechanical wear resistance, especially at high temperatures, with very good corrosion resistance. Stellite alloys are mostly cobalt based with additions of Cr, C, W, and/or Mo. They are resistant to cavitation, corrosion, erosion, abrasion, and galling. The lower carbon alloys are generally recommended for cavitation, sliding wear, or moderate galling.

ALLOY	NOMINAL ANALYSIS OF POWDER <sup>1</sup>								Others	UNS	Hardness (HRC) <sup>2</sup>
	Co	Cr	W	C	Ni	Mo	Fe	Si			
Stellite alloy 4	Bal.	30	13.5	0.7	<2.5	<1.0	<2.5	<1.0	<1.0	R30404	40–50
Stellite alloy 6	Bal.	28.5	4.6	1.2	<2.0	<1.0	<2.0	<2.0	<1.0	R30106	40–46
Stellite alloy 6LC	Bal.	29	4.5	1.1	<2.0	<1.0	<2.0	<2.0	<1.0	—	38–44
Stellite alloy 6HC	Bal.	28.5	4.6	1.35	<2.0	<1.0	<2.0	<2.0	<1.0	—	43–53
Stellite alloy 156	Bal.	28	4	1.7	<2.0	<1.0	<0.5	<2.0	<1.0	—	46–54
Stellite alloy 12	Bal.	30	8.5	1.45	<2.0	<1.0	<2.0	<2.0	<1.0	R30012	43–53
Stellite alloy 20	Bal.	32.5	17.5	2.55	<2.0	<1.0	<2.0	<1.0	<1.0	—	52–62
Stellite alloy 21	Bal.	27.5	—	0.25	2.6	5.4	<2.0	<2.0	<1.0	R30021	27–40 *
Stellite alloy 22	Bal.	28	—	0.3	1.5	12	<3.0	<2.0	<0.5	—	41–49 *
Stellite alloy 25	Bal.	20	15	0.1	10	<1.0	2	<1.0	1.9%Mn	—	20–45 *
Stellite alloy 31	Bal.	26	7.5	0.5	10.5	<1.0	<2.0	<1.0	<0.5	R30031	20–35 *
Stellite alloy F3	Bal.	26	12.5	1.8	22	<1.0	<2.0	1.1	<0.5	R30002	40–45
Stellite alloy 190	Bal.	26	14	3.4	<2.0	<1.0	<2.0	<1.0	<1.0	R30014	55–60
Stellite alloy 250	Bal.	28	<1.0	0.1	<1.0	<1.0	20	<1.5	<1.0	—	20–28
Stellite alloy 694	Bal.	28.5	19.5	0.9	5	—	<3.0	<1.0	1%V	—	46–52
Stellite alloy 706	Bal.	29	—	1.25	<2.0	4.5	<2.0	<1.0	<1.0	—	39–44
Stellite alloy 712	Bal.	29	—	2	<2.0	8.5	<2.0	<1.0	<1.0	—	46–53

NOTE: <sup>1</sup>-Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specifications/standard used when ordering.

<sup>2</sup>-Undiluted weld metal.

\*Depending on the degree of work hardening.

## TRIBALLOY™ PTA Powders

TRIBALLOY alloys, with either a nickel or cobalt base, were developed for applications in which extreme wear is present in high-temperature, highly corrosive environments. Their high molybdenum content accounts for the excellent self-lubricating properties of TRIBALLOY alloys and makes them very suitable for use in adhesive (metal-to-metal) wear situations. TRIBALLOY alloys can be used up to 1000° C (1832° F).

ALLOY	NOMINAL ANALYSIS OF POWDER <sup>1</sup>								Others	UNS	Hardness (HRC) <sup>2</sup>
	Co	Cr	W	C	Ni	Mo	Fe	Si			
TRIBALLOY alloy T-400	Bal.	8.5	—	<0.08	<1.5	29	<1.5	2.8	<1.0	R30400	51–57
TRIBALLOY alloy T-400C	Bal.	14	—	<0.08	<1.5	27	<1.5	2.6	<1.0	—	51–57
TRIBALLOY alloy T-401	Bal.	17	—	0.2	<1.5	22	<1.5	1.3	<1.0	—	45–50
TRIBALLOY alloy T-800	Bal.	17	—	<0.08	<1.5	29	<1.5	3.7	<1.0	—	53–61
TRIBALLOY alloy T-900	Bal.	18	—	<0.08	16	23	<1.5	2.8	<1.0	—	48–55

NOTE: <sup>1</sup>-Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specifications/standard used when ordering.

<sup>2</sup>-Undiluted weld metal.

## Deloro™ PTA Powders

The Deloro alloys are typically nickel based and cover a very wide range of hardness from soft, tough, built-up alloys that are easily machined or hand finished to exceptionally hard, wear-resistant alloys. The lower hardness Deloro alloys are typically used for glass forming molds. The higher hardness Deloro alloys are used in severe wear applications, such as rebuilding the flights of feeder screws, and they can be blended with carbides for an even harder deposit. They maintain their properties up to temperatures of about 600° F (315° C) and also offer great oxidation resistance.

ALLOY	NOMINAL ANALYSIS OF POWDER <sup>1</sup>								Others	UNS	Hardness (HRC) <sup>2</sup>
	Co	Cr	W	C	Ni	Mo	Fe	Si			
Deloro alloy 22	—	—	—	<0.05	Bal.	—	<1.0	2.5	1.4%B	—	20–22
Deloro alloy 30	—	9	—	0.2	Bal.	—	2.3	3.2	1.2%B	—	27–31
Deloro alloy 38	—	—	—	0.05	Bal.	—	0.5	3	2.1%B	—	35–39
Deloro alloy 40	—	7.5	—	0.3	Bal.	—	2.5	3.5	1.7%B	N99644	38–42
Deloro alloy 45	—	9	—	0.35	Bal.	—	2.5	3.7	1.9%B	—	44–47
Deloro alloy 46	—	—	—	0.05	Bal.	—	—	3.7	1.9%B	—	32–40
Deloro alloy 50	—	11	—	0.45	Bal.	—	3.3	3.9	2.3%B	N99645	48–52
Deloro alloy 55	—	12	—	0.6	Bal.	—	4	4	2.7%B	—	52–57
Deloro alloy 60	—	15	—	0.7	Bal.	—	4	4.4	3.1%B	N99646	57–62

NOTE: <sup>1</sup>-Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specifications/standard used when ordering.

<sup>2</sup>-Undiluted weld metal.

## NISTELLE™ PTA Powders

NISTELLE alloys are designed for corrosion resistance rather than wear resistance, particularly in aggressive chemical environments where their high chromium and molybdenum contents provide excellent pitting resistance. As a class, they are also generally resistant to high-temperature oxidation and hot gas corrosion. Care should be taken to select the correct alloy for any given corrosive environment.

ALLOY	NOMINAL ANALYSIS OF POWDER <sup>1</sup>								Others	UNS	Hardness (HRC) <sup>2</sup>
	Co	Cr	W	C	Ni	Mo	Fe	Si			
NISTELLE alloy "Super C"	—	23	—	0.1	Bal.	18	<1.0	<1.0	—	—	15–25 *
NISTELLE alloy C	—	17	4.5	0.1	Bal.	17	6	<1.0	0.3%V	—	17–27 *
NISTELLE alloy C4C	—	16	—	—	Bal.	16	<1.0	<1.0	—	N06455	—
NISTELLE alloy C22	<2.0	21.5	3	—	Bal.	13.5	4	—	0.15%V	—	—
NISTELLE alloy C276	—	15.5	3.7	—	Bal.	16	5.5	<1.0	0.15%V	—	—
NISTELLE alloy X	1.5	22	<1.0	0.15	Bal.	9.1	18.5	<1.0	<1.0%	N06002	—
NISTELLE alloy 305	—	42	—	—	Bal.	—	—	0.5	<1.0%	—	—
NISTELLE alloy 2315	—	20	—	—	Bal.	—	—	<1.0	<1.0%	—	—
NISTELLE alloy 600	—	15.5	—	—	Bal.	—	8	<0.5	<1.0%	N06600	—
NISTELLE alloy 625	—	21.5	—	<1.0	Bal.	9	<1.0	<0.5	3.5% Nb	N06625	—
NISTELLE alloy 718	<2.0	21.5	3	—	Bal.	13.5	4	—	0.15%V	N07718	—

NOTE: <sup>1</sup>-Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specifications/standard used when ordering.

<sup>2</sup>-Undiluted weld metal.

\*Depending on the degree of work hardening.

## Delcrome™ PTA Powders

The Delcrome family are iron-based alloys developed to resist abrasive wear at lower temperatures, typically up to 392° F (200° C). When compared with our cobalt- and nickel-based alloys, their corrosion resistance is also comparatively low.

ALLOY	NOMINAL ANALYSIS OF POWDER <sup>1</sup>								Others	UNS	Hardness (HRC) <sup>2</sup>
	Co	Cr	W	C	Ni	Mo	Fe	Si			
Delcrome 90	—	27	—	2.9	—	—	Bal.	<1.0	0.5%Mn	—	Depends on heat treatment
Delcrome 92	<0.5	<1.0	—	3.8	<1.0	10	Bal.	<1.0	<1%Mn	—	55–63
Delcrome 253	<0.5	28	—	1.9	16.5	4.5	Bal.	1.3	0.8%Mn	—	—
Delcrome 316	<0.5	17	—	0.05	11	2.6	Bal.	2.5	0.4%Mn	—	<180 DPH
Delcrome 316L Delcrome 317	<0.5	18	—	<0.03	13	2.6	Bal.	1.8	0.7%Mn	—	<180 DPH
Delcrome 6272	<0.5	25	—	2.5	14	7	Bal.	1.8	<1.0%	—	—

*NOTE: <sup>1</sup>-Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specifications/standard used when ordering.*

*<sup>2</sup>-Undiluted weld metal.*

## Additional Alloys

The Stellite™ family extends to a variety solutions across our other brands, including: Stelcar™, Ultimet™, Extrudalloy™, and Tristelle™. Each of these brands is engineered to combat unique wear and corrosion applications with tailored chemistries and mechanical properties.

In addition to the Kennametal comprehensive product portfolio, technical support and excellent customer service, engineers are available to assist in designing a comprehensive solution to your exact standards. With a variety of manufacturing methods and years of experience, Kennametal Stellite can tailor particle composition and size distribution to generate a one-of-a-kind solution for you.

*Kennametal, the stylized K, Delcrome, Deloro, Excalibur, Extrudalloy, MicroStar, MicroStar HPH, NISTELLE, STARWELD, Stelcar, Stellite, TRIBALLOY, Tristelle, and ValveStar are trademarks of Kennametal Inc., and are used as such herein.*

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