

High-performance

A complete product line based on
UBE U-varnish technology

Competitive advantage



UPIA®

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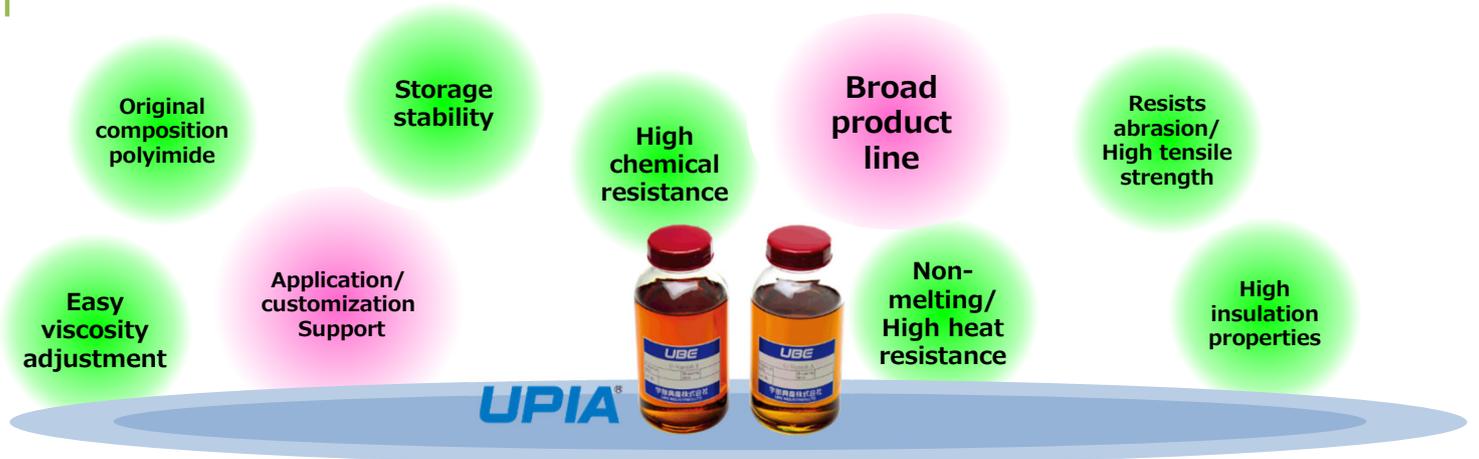
Creating UTOPIA with UBE

“UPIA®” is a complete Polyimide varnish product line based on UBE’s “U-varnish” brand, with new performance varnish grades developed from UBE’s extensive experience and Superior technology. UBE provides value and delivers solutions for a variety of applications through exceptional customer support.

Polyimide varnish "UPIA®" is a polyamic acid precursor solution of polyimide (High-performance engineering plastics). It is the base for polyimide coated films which feature non-soluble and non-melting properties, high heat, chemical resistance, and electric insulation properties achieved through high temperature curing and imidization.

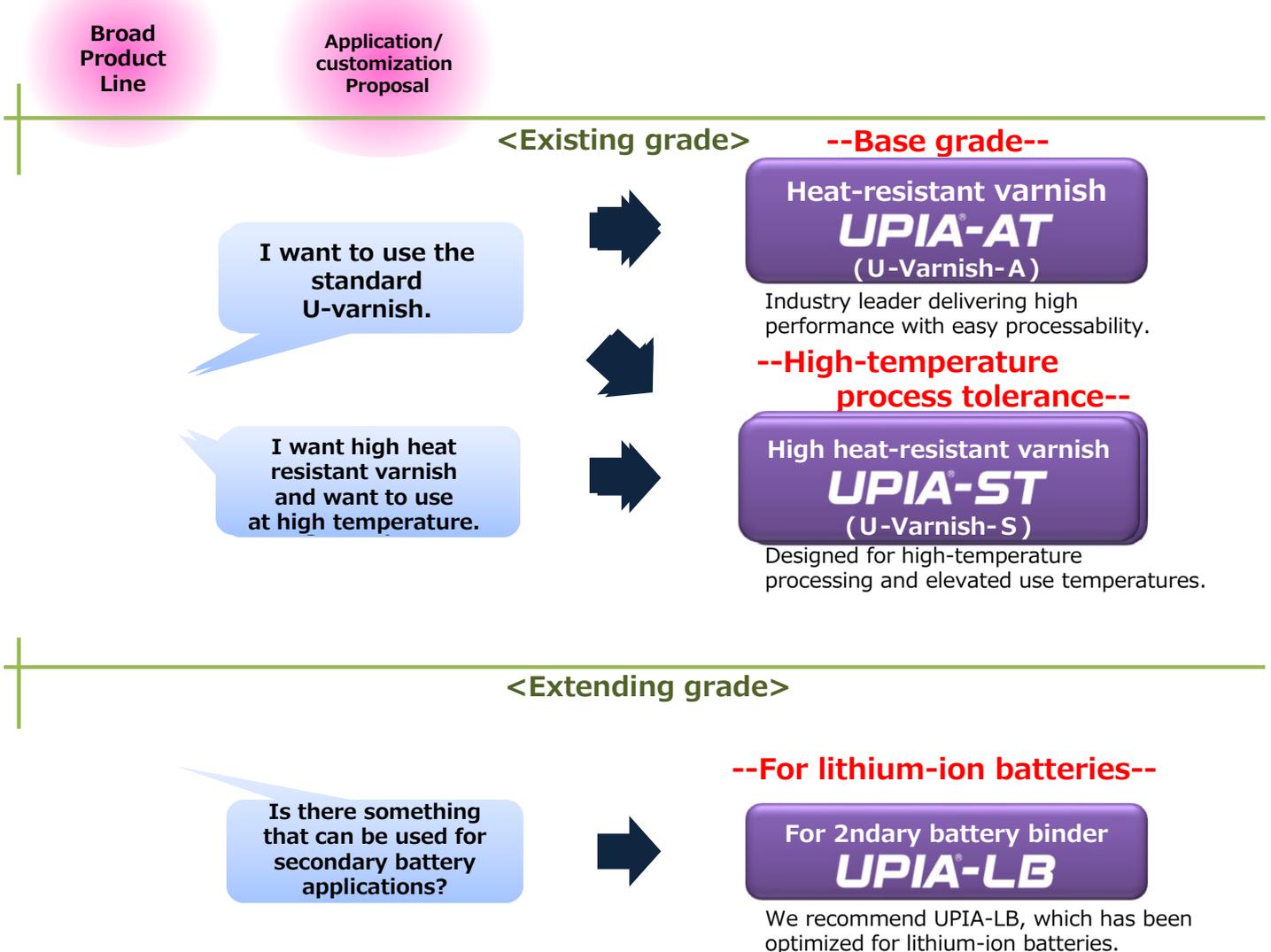
Advantage of "UPIA®"

"UPIA®" was created from UBE's unique polyimide synthesis technology which delivers significant advantages.



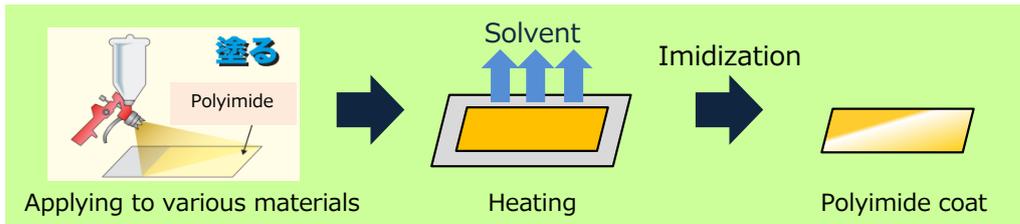
Proposed Application and grade

In order to satisfy our customers needs, we recommend the varnish grade which is optimized for the application and targeted end use characteristics. This is based on the many advantages of the standard grades of "UPIA®-AT (U-Varnish-A)" [Normal heat-resistant] and "UPIA®-ST (U-Varnish-S)" [High heat-resistant].



How to Use

Polyimide coating or film is created by applying varnish to various materials and then heating, which removes the solvent and completes the imidization reaction.

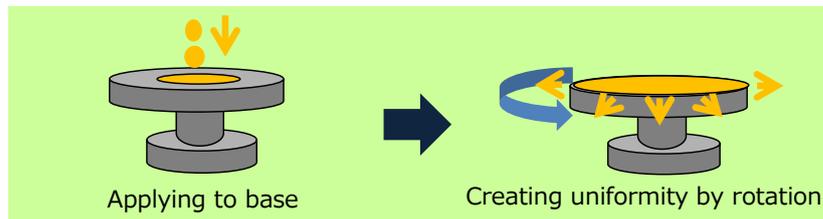


(1) Usage examples of polyimide coat

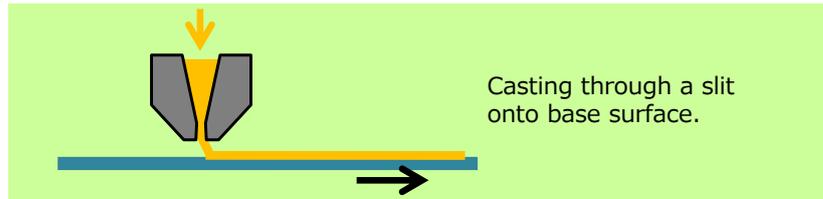
- Direct polyimide coating creates a polyimide film applying varnish to various materials and then heat curing.
Ex: Wire coating, coating of metal parts
- Polyimide coat obtained by applying to a metal plate, glass or other substrate, which, after heating, is released off and used as a polyimide film.
Ex: Seamless belt, Flexible device base
- Polyimide varnish is used as a mixture with other chemicals.
Ex: Additives for paste or paint, binder resin

(2) Coating method examples

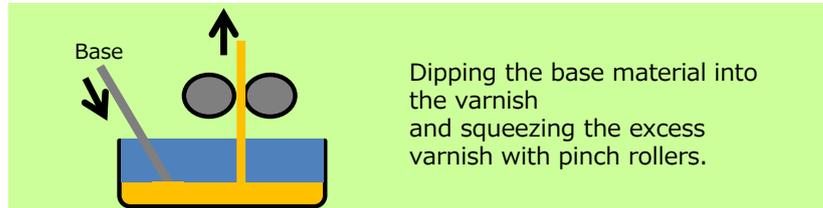
- Spin coating



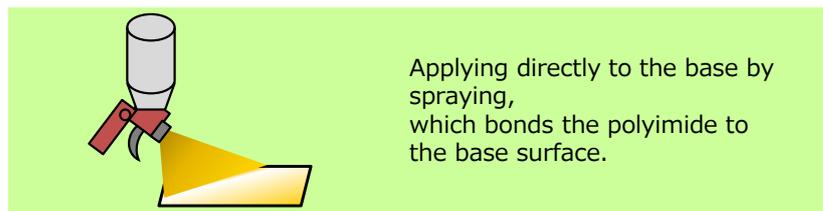
- Slit coating



- Dip coating



- Spray coating



Characteristics of "UPIA®"

(1) Composition of UBE Polyimide

Original composition polyimide

"UPIA®" is a polyimide precursor formed from UBE's proprietary "BPDA (Biphenyl tetracarboxylic dianhydride)" monomers. This is the original UBE varnish. UBE polyimide film "UPILEX®" is produced using this unique UBE polyimide precursor giving it various and unique advantages. Polyimide coated film derived from the varnish of the same graded has the same properties.

-- Features of UBE Polyimide film [**UPILEX®**] --

- High heat resistance---
It can be used in high-temperature processes just below 500°C.
This exceeds industry standard operating temperatures around 300°C.
- High mechanical properties---
Upilex has excellent wear resistance and toughness. This allows use of thinner films compared to other polyimide materials, in applications where strength is critical.
- Chemical resistance---
It has excellent chemical resistance to organic solvents, gasoline, automotive oil, alkalis, acids etc..

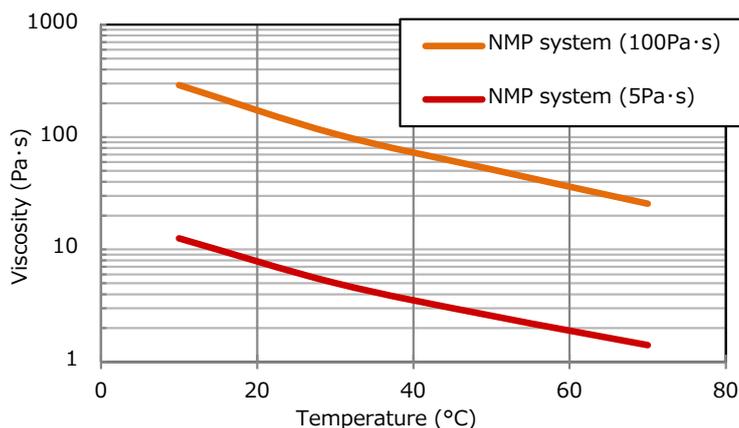


(2) General properties of "UPIA®"

Property	Category	Heat-resistant/High heat-resistant (Existing grade)	For secondary battery binder	Measurement condition
	Unit	UPIA-AT/ST (U-Varnish-A/S)	UPIA-LB	
Solvent	—	*NMP	*NMP, Water	
Solid content	Wt%	17-19	10-30	350°C, 30min
Density	×10 ³ kg/m ³	1.10-1.11	1.05-1.15	25°C
Solution viscosity	Pa·s	5-100	0.1-10	E-type, 30°C

*N-methyl-2-pyrrolidone

(3) Temperature dependence of solution viscosity



◆ ◆ Temperature dependence of solution viscosity ◆ ◆

(4) Concentration dependence of solution viscosity

Easy viscosity adjustment

"UPIA®" can be used at any desired concentration by diluting it with anhydrous NMP or DMAc (N, N-dimethylacetamide).

(5) Storage stability

Preservation stability

"UPIA®" has superior storage stability compared to conventional polyimide varnishes. It exhibits a very low increase in viscosity at room temperature, while conventional polyimide varnish must be refrigerated or frozen.

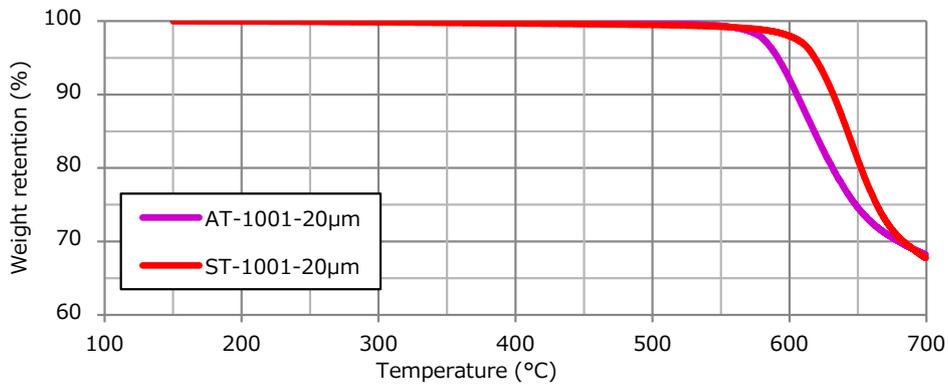
Coating Properties

(1) Thermal properties

Non-melting/
High heat resistance

Polyimide film obtained from "UPIA®" exhibits a high thermal decomposition temperature. Especially, "UPIA®-ST(U-Varnish-S)" has a thermal decomposition temperature above 550°C, so it does not soften, fluidize, or decompose under use temperatures and it is able to be used in high-temperature processes. In addition, the polyimide coating has excellent dimensional stability even at high temperatures.

Property	Unit	UPIA-AT (U-Varnish-A)		UPIA-ST (U-Varnish-S)		Measurement condition/ Method	
		1001	1001	1001	1001		
Thickness	μm	20	50	20	50		
Solvent	—	NMP		NMP			
Solid content	wt%	18.0±1.0		18.0±1.0		350°C, 30min	
Solution viscosity	Pa·s	5±1		5±1		E-type, 30°C	
Heat treatment highest temp.	°C	350		450			
Film properties	Glass-transition temp. T _g	°C	274	278	322	324	Dynamic viscoelasticity
	5% weight reduction temp.	°C	592	599	619	620	TGA
	Thermal linear expansion coefficient (50-200°C)	ppm/K	33	29	3	8	Fine linear dilatometer



◆ ◆ Heat weight loss curve ◆ ◆

(2) Mechanical properties

Resists abrasion/
High tensile strength

Polyimide coating derived from “UPIA®” demonstrates excellent mechanical properties, especially high tensile strength and abrasion resistance.

Property	Unit	UPIA-AT (U-Varnish-A)		UPIA-ST (U-Varnish-S)		Measurement Method
		1001		1001		
Thickness	µm	20	50	20	50	
Film properties						
Tensile strength	MPa	229	238	526	482	ASTM D882
Elongation	%	92	99	35	40	ASTM D882
Tensile modulus	GPa	3.7	3.7	9.8	9.3	ASTM D882

(3) Electric properties

High insulation properties

Polyimide coat obtained from “UPIA®” delivers a high electrical reliability, such as insulation.

Property	Unit	UPIA-AT (U-Varnish-A)		UPIA-ST (U-Varnish-S)		Measurement condition/ Method
		1001		1001		
Thickness	µm	20	50	20	50	
Breakdown voltage	kV	7.7	10.3	7.0	10.2	ASTM D149
Volume resistivity	Ω·m	>10 ¹⁴	>10 ¹⁴	>10 ¹⁴	>10 ¹⁴	ASTM D257
Surface resistance	Ω	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	>10 ¹⁶	ASTM D257

(4) Chemical-Resistant Properties

High chemical resistance

“UPIA®” has excellent resistance to common organic solvents and metallic salt solutions, and it also demonstrates better resistance to acids and alkalis than conventional products.

In addition, it delivers superior performance when it comes to abrasion resistance and non-flammability.

◆ ◆ Chemical resistance data of UPIA-AT-1001(U-Varnish-A) ◆ ◆

Chemical	Characteristic value (Thickness: 20µm)	
	Strength retention rate (%)	Elongation retention rate (%)
Methylene chloride	95	96
Chloroform	88	90
Trichloroethylene	93	102
Methyl ethyl ketone	92	89
Ethanol	89	100
Xylene	99	84
m-Cresol	90	90
N-methyl-2-pyrrolidone	98	107
Glacial acetic acid	91	108
10% hydrochloric acid	91	82
10% sulfuric acid	93	94
2% sodium hydroxide	99	91
10% sodium hydroxide	82	81

Measurement condition: 30°C, 24h Dipping

Specialty grade (Details)

We will continue to develop special varnish grades delivering unique advantages for specific applications, based on properties of high heat resistance and chemical resistance.

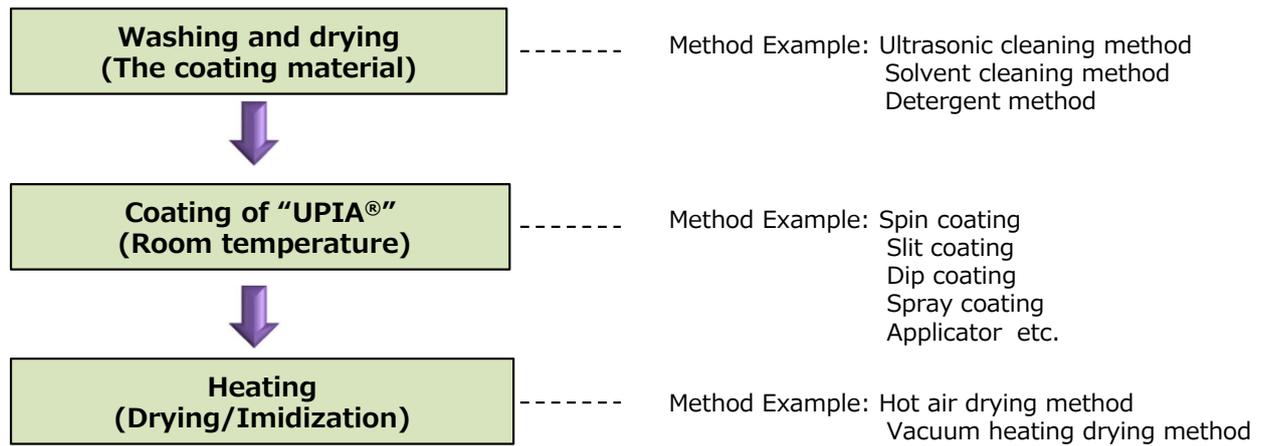
(2) For secondary battery binder **UPIA-LB**

We have optimized UPIA-LB for lithium-ion battery binder applications.

- For battery binder applications, we strengthened and optimized the required characteristics according to our customers needs.
- UPIA-LB has the necessary toughness to overcome significant expansion of the electrode material.
- This varnish has high adhesion to Copper, aluminum and SUS, so you should improve the adhesion to the current collector compared to other binder types.
- This polyimide binder is highly resistant to the chemical exposure, it maintains performance, such as cracking resistance and adhesive strength, even immersed in the electrolyte solution.
- It has excellent long-term heat resistance, so it is able to be used in high-temperature applications.
- UPIA-LB has excellent physical properties, even with relatively low temperature processing.

Property	Unit	UPIA-AT (U-Varnish-A)		UPIA-LB				Measurement condition	Measurement Method	
		1001	2001	1001	2001	2001	2001			
Thickness	μm	20	20	20	20	20	20			
Heat treatment highest temp.	°C	200	350	200	350	150	200			
Solvent	—	NMP		NMP		Water				
Solid content	wt%	18.0±1.0		30.0±1.0		18.0±1.0		350°C,30min		
Solution viscosity	Pa·s	5±1		5±1		0.5±0.2		E-type, 30°C		
Film properties	Cu adhesion	—	5B	5B	5B	5B	5B		ASTM D3359	
	Al adhesion	—	5B	5B	5B	5B	5B		ASTM D3359	
	SUS adhesion	—	5B	5B	5B	5B	5B		ASTM D3359	
	Tensile strength	MPa	175	229	199	278	127	132		ASTM D882
	Elongation	%	70	92	88	107	53	45		ASTM D882
	Tensile modulus	GPa	3.2	3.7	3.2	4.0	2.8	3.2		ASTM D882
	Break energy	MJ/m ³	86	150	118	191	70	75		ASTM D882
Electrolytic liquid resistance	Weight change rate	%	+1.2	+0.2	+0.1	±0	±0	±0	25°C×24h Electrolytic liquid dipping	
	Thickness change rate	%	+0.5	±0	+0.1	±0	±0	±0		
	Tensile strength retention	%	97	100	103	102	98	100		ASTM D882
	Elongation retention	%	100	99	103	103	104	100		ASTM D882
	Break energy retention	%	100	100	102	104	101	100		ASTM D882

Usage (Examples)



Packing and handling precautions

(1) Standard Packing

Packing	18kg can
	5kg can



(2) Handling precautions

- "UPIA®" is extremely stable when properly stored. Please keep it in a cool, dark place when storing for a long period of time. Always keep the lid tightly sealed when storing to prevent hydrolysis due to moisture absorption. Immediately wipe off any varnish that comes into contact with the skin and then thoroughly wash the affected area.
- Please refer to Safety Data Sheet (SDS) before use.
- "UPIA®" NMP based systems are classified as a Type 3 Petroleum Substance, Type 4 Hazardous Material under Japan's Fire Defense Law (designated quantity: 2,000 liters).

(3) Content Statement

The content provided is based on materials, data and information currently available. No guarantee is made with regard to content, physical properties or hazardous and harmful effects. Furthermore, handling precautions relate to normal handling. In unique situations requiring special handling, please use safety measures appropriate for the application and process.



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