BIEGLO

AURUM®

超耐熱・熱可塑性ポリイミド樹脂 ——— オーラム®

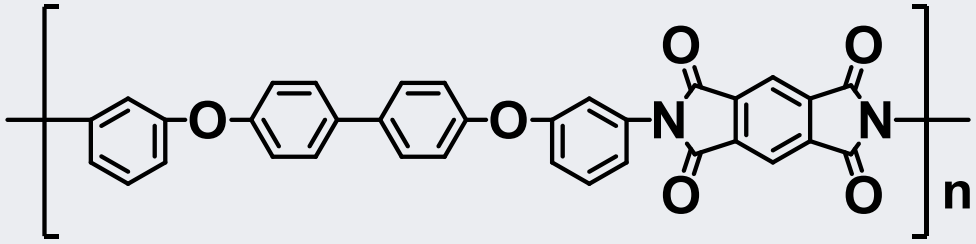
Thermoplastic Polyimide TPI

0→1 MAKE IT HAPPEN

Contents

What is AURUM®?

AURUM® is Semicrystalline Thermoplastic polyimide (TPI) suitable for Injection Molding and Extrusion process with outstanding Tg =245°C.



Metal & Ceramics replacement

Features of AURUM®

Excellent heat resistance	Usable up to 240°C (Tg=245°C, Tm=388°C)
Excellent dimensional stability & High mechanical properties	Stable CLTE, Excellent creep resistance
Outstanding wear and friction properties	Stable and low coefficient of friction & low abrasion loss
Exceptional Clean properties	Lower amount of Metallic Impurities & out-gasing
Stable in any Environment	Excellent Plasma & radiation resistance, resistance to chemicals Oil & solvents at elevated temps.
Excellent electrical insulation performance	Very good dielectric properties

AURUM® Advantages over HPPs

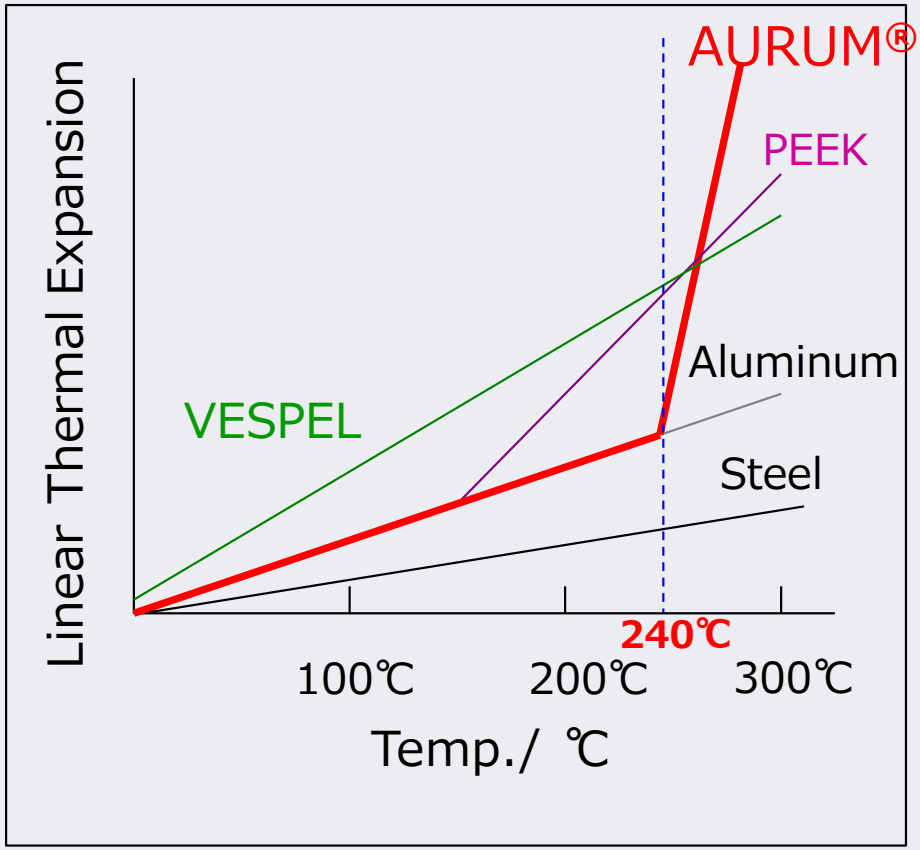
Mitsui Chemicals

AURUM vs Thermoset PI	○ AURUM can be produced with Injection molding & Extrusion and suitable for high production rate ○ Thermoset PI: requires special processing and available in semi finished parts which requires machining
AURUM vs PAI	○ AURUM No need of post annealing process, Flexibility in parts design ○ PAI requires post annealing process, and this time consuming and costly , Special equipment is required for annealing
AURUM vs PEEK	○ AURUM High temperature stiffness in the 150 ~ 230 °C temperature range (Higher Tg), Low coefficient of thermal expansion above 150 °C, Dimension Stability ○ PEEK performance drops over its Tg (140°C)
AURUM vs PEI	○ AURUM Higher Tg, better chemical resistance

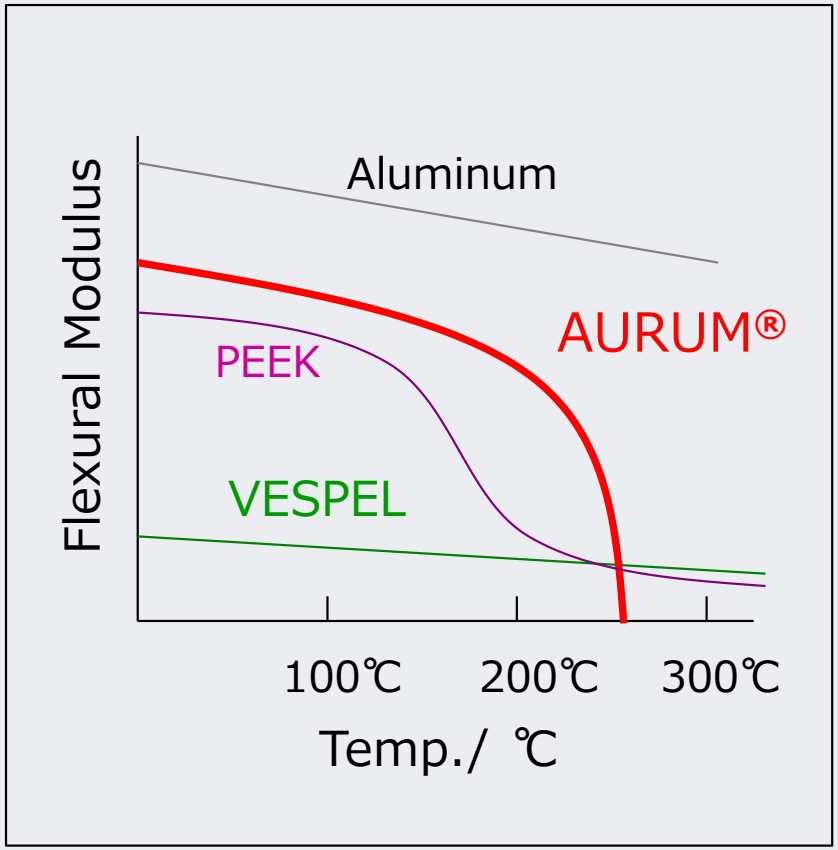
AURUM® Characteristics(comparison with competitors)

Mitsui Chemicals

Feature1 : Dimaensional stability



Feature2 : High Modulus up to 240° C



CLTE : Stable up to 240° C , equivalent with Aluminum
Keep high Flexural modulus up to 240 °C

AURUM® vs PEEK

Mitsui Chemicals

	Test method	unit	AURUM® PL450C	PEEK KT-820NT (solvay)	PEEK AV-630NT (solvay)	PEEK 450G (VICTREX)
MFR	400℃×1.05kg	g/10min	6	-	-	-
	400℃×2.16kg	g/10min	-	3	7	3
Tm(DSC)	ASTM D3418	℃	388	340	340	343
Tg(DSC)	ASTM D3418	℃	**245**	150	158	143
Tensile Strength	ASTM D638	MPa	100	100	90	90
Tensile Elongation	ASTM D638	%	**100**	20-30	50-80	70
Flexural Strength	ASTM D790	MPa	130	150	130	150
Flexural Modulus	ASTM D790	GPa	2.6	3.7	3.2	3.7
IZOD	ASTM D256	J/m	90	90	-	80
HDT	ASTM D648	℃	**225**	157	181	154

Advantages (VS PEEK) : heat resistance, mechanical properties

2. AURUM® Suggestion for insulating coating of magnet wires

Suggestion for insulating coating of magnet wires

Technology Trend
: Higher Power and Miniaturization

Requirements For Parts Insulating Coatings

①Breakdown voltage (high temp.)
②PDIV (high temp.)
③Flexibility (SS-curve)
④Chemical resistance
⑤Heat aging resistance

AURUM®, in particular, has stable properties at high temperatures, enabling thinner insulating coating, which contributes to higher output and miniaturization of motors.

Competitive Comparison Table (①Breakdown Voltage, ②PDIV)

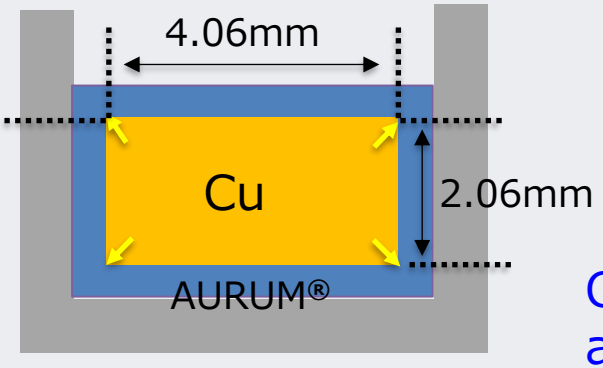
Mitsui Chemicals

Underlines are literature values

Property		unit	AURUM PL450C	PEEK 450G	PAI Catalog data	Epoxy
Coating process			Extrusion	Extrusion	Dipping	Dipping
Tg/Tm		℃	**245 / 388**	143 / 343	275 / -	~200 /-
Breakdown voltage	23℃	kV/mm	**23**	18	24	-
	180℃		**25**	17	-	-
Dielectric Constant (1kHz)	23℃		**3.1**	3.2	4.0～4.6	3.4~4.4(1GHz)
	180℃		**3.1**	**3.9**	4.2(1.5kHz)	-

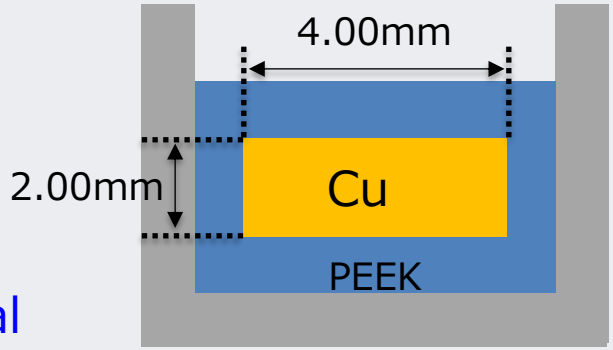
Ex.)PDIV:1200 Vp@180℃

【Dakin formula】 $V = \sqrt{2} \times 163 \times (t/\varepsilon_r)^{0.46}$
V : Partial discharge inception voltage [Vp] ε_r : Dielectric constant of insulating material
t : Thickness of insulating material [μm]



AURUM® : 112um

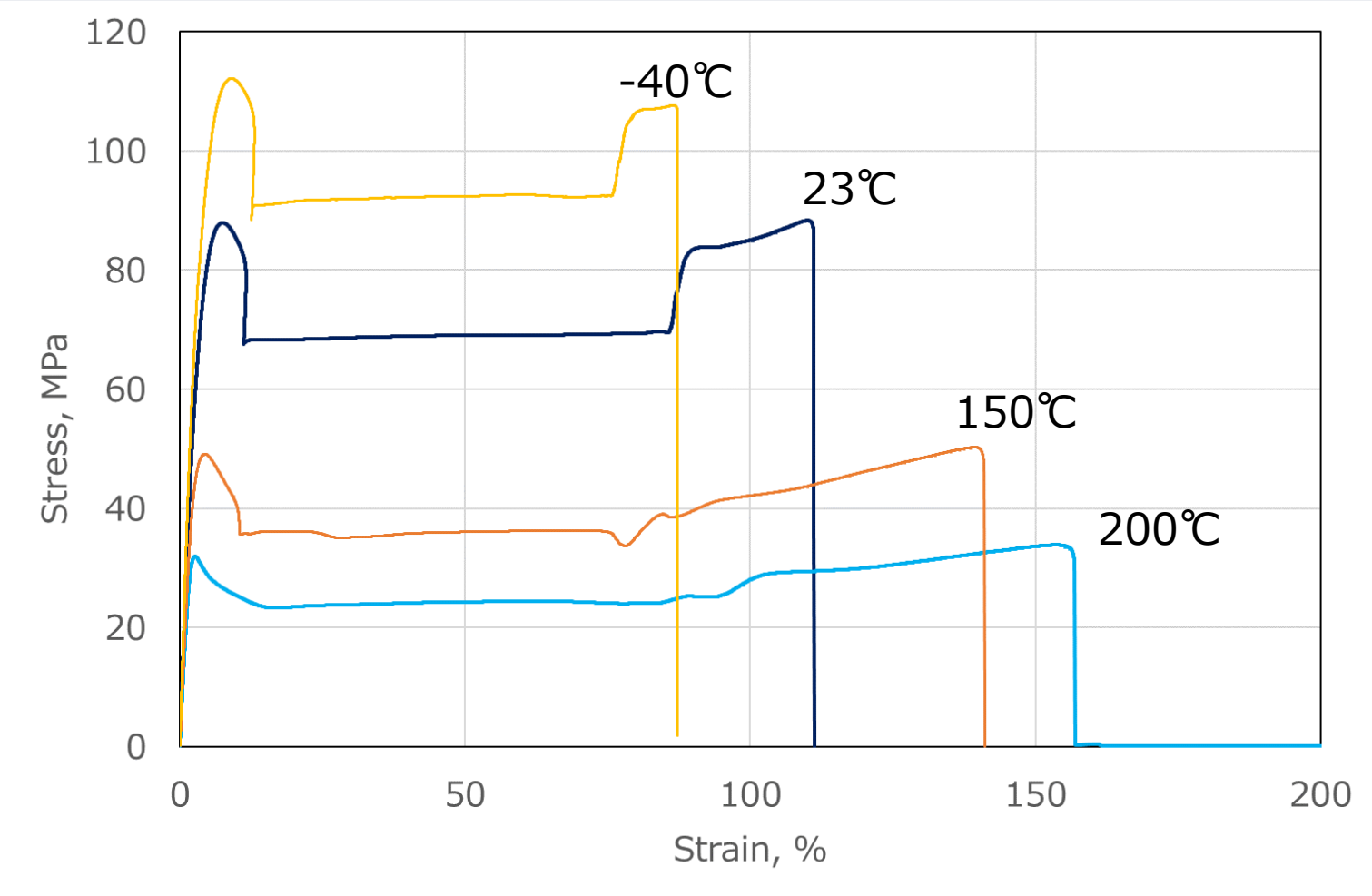
Cross-sectional area of conductor improved up to 20%



PEEK : 141um

③Flexibility SS-curve

▼Tensile test/PL450C



AURUM has sufficient flexibility characteristics.

④Chemical resistance

Mitsui Chemicals

Test grade : AURUM PL450C
Evaluation : tensile strength/Elongation、weight loss
chemical : engine oli、ATF
Dip temp : 160 ℃

Engine Oil（160 ℃）			
Dip time	Tensile strength	Tensile elongation	Weight loss
hrs	MPa	%	%
0	96	95	
100	96	96	0.04
200	96	86	0.12
500	97	89	0.11
1000	98	86	0.11

ATF（160 ℃）			
Dip time	Tensile strength	Tensile elongation	Weight loss
hrs	MPa	%	%
0	96	95	
100	97	96	0.03
200	97	90	0.03
500	97	89	0.06
1000	97	95	0.03

No significant change in properties was observed after immersion for 1000h.

⑤Heat aging resistance

Test grade : AURUM PL450C
Evaluation : tensile strength/Elongation
Test temp : 230℃

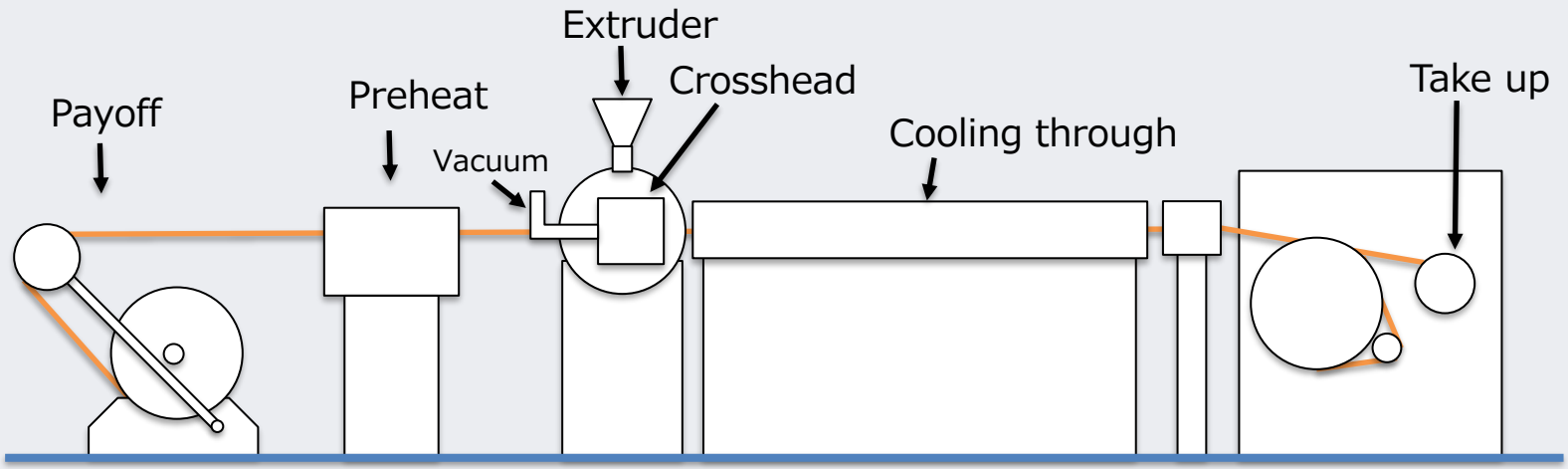
Tensile test	unit	AURUM® PL450C			
		Initial	100 Hrs	500 Hrs	1,000 Hrs
Tensile Strength	%	100	90	90	85
Tensile Elongation	%	100	85	85	80
Tensile Modulus	%	100	110	110	110
Weight loss	%	-	0.1>	0.1>	0.1>

No significant change in properties was observed at 230℃

3. AURUM Extrusion Processing Recommended Conditions

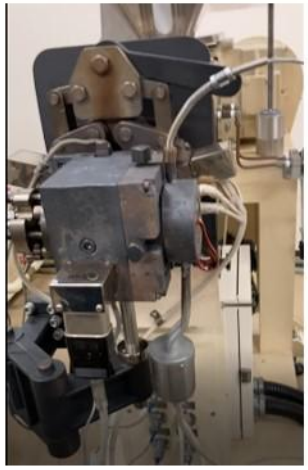
AURUM Extrusion Processing Recommended Conditions

Mitsui Chemicals



Payoff

Preheater



Extruder
Crosshead

Die

Cooling Through

AURUM Extrusion Processing Recommended Conditions

Mitsui Chemicals

◆ Initial recommended temperature for each process

Item	Recommended Temperature
First half of cylinder (below hopper)	380-400°C
Middle of cylinder	400-420°C
Second half of cylinder (die side)	400-420°C
Die	400-430°C
Copper Wire; Preheating Temperature	≧ 300°C

◆ Example of Trial Production

・Conductor: Flat angle copper wire (oxygen free copper)
Size 1.54mm x 2.99mm

・Extruder : 25 mmφ, L/D25
・Mesh : 30/60/100/100/60

・Die : Tubing Die
・Grade : PL450C (Standard Brand)

Coating Thickness	Condition							
	Line Speed	Screw Rotation	Extrusion temperature ℃					
μm	m/min	rpm	C1	C2	C3	Flange	Head	Die
60	4.0	4.5	390	400	410	410	410	400
120	2.0	3	↑	↑	↑	↑	↑	↑
240	1.5	4.5	↑	↑	↑	↑	↑	↑
130	2.0	3	390	410	420	420	420	410
220	1.5	4.5	↑	↑	↑	↑	↑	↑

AURUM Extrusion Processing Recommended Conditions

Mitsui Chemicals

◆ Extruder Maintenance

・Before extrusion, it is recommended to disassemble and clean the extruder so that the extruder is empty.
*To prevent contamination.

◆ Preparation

・It is recommended to dry the pellet at 200°C for 5hr or more, preferably 12hr or more.
*If possible, it is recommended to dry the pellet in a dryer until just before it is inserted.

・If necessary, degreasing treatment of the copper wire is recommended.

・If it is necessary to improve adhesion, it is recommended to heat the copper wire beforehand.

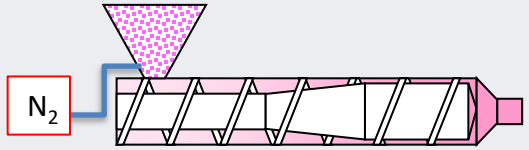
AURUM Extrusion Processing Recommended Conditions

Mitsui Chemicals

◆ Extrusion

■ Extrusion atmosphere

・Nitrogen is introduced into the extruder from the hopper and nitrogen replacement is recommended.
*To prevent viscosity increase and gelation (black spots/fish eyes) due to thermal oxidation.



■ Startup

・At a low screw speed of about 3rpm, take pellets into a heat-resistant cup, etc.
It is recommended to inject a very small amount into the hopper (starvation feed).

■ During extrusion

・We recommend that the amount of pellets taken out of the dryer at one time should be used up within 60min (Within 30min if nitrogen purge is not possible).

・Just before the pellets run out of the hopper, replenish the dried pellets each time to avoid empty pellets in the hopper.

・Do not stop the rotation of the screw. If sampling is not performed during breaks, place the pellet in a hopper so that it does not short out. Keep the rotation of the screw at a low speed.

・We recommend that the resin residence time in the extruder be 10min or less.

・Keep warm and control the temperature so that the temperature of the extruder or the die does not fall below the melting point (388°C).
*Crystallization (solidification) can lead to problems such as torque over, blockage, and mixing of solids into the coating layer.

■ Purge after extrusion

・It is recommended to replace with an engineering plastic material that is compatible with the extrusion temperature of Aurum, and then replace with a general purge material.
*Recommended engineering plastic/purge material: PEI (ULTEM#1000)

Thanks for Your Attention!