

# Novamid: Portfolio and typical properties for extrusion

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## Introduction

### About DSM

The strength of DSM is its global footprint with production facilities and sales offices distributed all over the world. DSM is the 2nd largest supplier of Polyamide 6 in the world and is backward integrated right from the feedstock Caprolactam to the end Polyamide 6 polymer and compounds. By leveraging this strength as a global company, we believe we can bring value to you and service your business globally.

### About Novamid

Novamid® is DSM's brand of specialty PA6 and PA66 Homopolymer, PA6/66 copolymer, and amorphous polyamides. Together with Akulon, DSM's global brand of PA6, DSM has now a complete portfolio of PA6, PA66, and specialty polyamides.

Novamid allows for customizations in formulations for the processes and applications that customers demand and offers a wide array of services in Japan, while Akulon offers customers the benefits of globalization and scale.

Novamid supports a wide variety of processing techniques, from injection molding to film extrusion.

This brochure attempts to introduce the properties and portfolio of grades of Novamid supporting extrusion processes.

### Novamid for extrusion

Novamid features a portfolio of grades for extrusion applications such as films, monofilaments, tubes, and others.

The properties of Novamid are:

- Tough and superior strength
- Good performance at low temperature
- Superior thermoformability
- Good heat resistance
- Excellent puncture resistance
- Excellent barrier properties to oxygen and water vapor
- High transparency

## Nomenclature

Nomenclature of Novamid extrusion grades

The first digit shows the type of polyamide.

1○○○: PA6

2○○○: PA6/66 co-polymer

The second digit shows the type of co-polymer

The third and fourth digits show the molecular weight of base resin.

## Novamid Grade Overview for Film

The table below shows the line-up of grades for film. You could choose the suitable grade for each film-making process and layer.

Type	Grade	Characteristics	Application							
			BOPA film		Cast film		Air cooled blown film		Water chilled blown film	
			Outside layer	Inside layer	Outside layer	Inside layer	Outside layer	Inside layer	Outside layer	Inside layer
Homo	1020	Mid viscosity	-	++	-	+++	-	+++	-	+++
	1020A	Mid viscosity for film (general purpose)	-	++	+	++	+	++	+	++
	1020CA2	Mid viscosity for film (especially suitable for air-cooled)	-	-	++	-	+++	-	++	-
	1022C6	Mid viscosity for film (especially suitable for BOPA)	+++	-	++	-	+	-	++	-
	1022A	Mid viscosity for film (general purpose)	-	++	+	+	+	++	+	++
	1022CZ3	Mid viscosity for film (especially suitable for water-chilled)	-	-	++	-	++	-	+++	-
	1030CA4	High viscosity for film (especially suitable for cast)	-	-	+++	-	++	-	+	-
6/66	2020A-1	Mid viscosity, CoPA for film (general purpose)	-	+	++	++	+++	++	+++	++
	2030A	High viscosity, CoPA for film (general purpose)	-	+	++	++	+++	++	+++	++
	2030CA	High viscosity, CoPA for film (especially suitable for air-cooled)	-	-	++	-	+++	-	++	-
	2030CA FC	High viscosity, CoPA for film for food contact applications	-	-	++	-	+++	-	++	-
	2030FC	High viscosity, CoPA for film for food contact applications	-	-	-	+++	-	+++	-	+++
	2430A1	High viscosity, CoPA for film (higher transparency, soft)	-	+	++	++	+++	++	++	++
	6I/6T	X21-Fo7	Special amorphous PA	Blending material with another PA						

+++ Particularly suitable

++ Suitable

+ Possible to use

- Not suitable

Typical properties such as viscosity, transparency, surface-slip and mechanical properties of film made by casting and air-blown process are shown below.

### Typical properties of cast film made of Novamid

Properties	Test Method	Conditions	Units	1030CA4	1030
<b>Rheological properties</b>					
Melt Mass-flow Rate	ISO 1133	230°C	g/10min	2.6	2.6
Melt Volume-flow Rate		2.16kg	cm <sup>3</sup> /10min	2.3	2.3
<b>Mechanical properties</b>					
Thickness of film			μ	30	30
Tensile strength at yield	ASTM D-882	23°C, 65% RH	MPa	25	20
Tensile strength at break				110	110
Tensile modulus				600	550
Tensile elongation at break				%	450
Co-efficient of static friction	ASTM D-1894		μs	1	2.5
<b>Optical properties</b>					
Haze	ASTM D-1003	23°C, 65% RH	%	1	0.6
<b>Gas permeability</b>					
Oxygen	ASTM D-3985	23°C, 0% RH	cc/m <sup>2</sup> .day.MPa	50	50
		23°C, 5% RH	cc/m <sup>2</sup> .day.MPa	130	130
Water vapor	JIS-Z0208	40°C, 0% RH	g/m <sup>2</sup> .day	350	350

### Typical properties of air-cooled film made of Novamid

Properties	Test Method	Conditions	Units	1022CZ3	1030CA4	1030CA FC	2030CA FC
Melt Mass-flow Rate	ISO 1133	230°C	g/10min	8.5	2.6	2.6	2.6
Melt Volume-flow Rate		2.16kg	cm <sup>3</sup> /10min	7.5	2.3	2.3	2.3
Thickness of film			μ	30	30	30	30
Tensile strength at yield	JIS K7127	23°C, 65% RH	MPa	25	25	30	20
Tensile strength at break				110	110	110	110
Tensile modulus				600	600	600	400
Tensile elongation at break				%	450	450	450
Co-efficient of static friction	ASTM D-1894		μs	0.6	1.0	0.6	1.0
Haze	JIS K7105	23°C, 65% RH	%	3.6	2.3	25	6

### Typical extrusion and casting conditions for Novamid

		Novamid	PE/PP
Extruder	L/D	24-28	22-24
Screw	Type	Full-flight type	Full-flight type
	Compression ratio	3.0 - 3.5/Rapid compression	2.0 - 3.0
Drying before processing		Not needed	Not needed
Extrusion temperature	Cylinder	230-260°C	100-210°C
	Die	230-260°C	100-210°C
Cast Temperature		30-80°C	30-60°C
Process		Cast	Cast
		Blown (air-cooling, water chilling)	Blown (air-cooling, water chilling)
		Monofilament	
Co-Extrusion		Possible	Possible
Stretch		Possible	Possible

### Novamid Grade Overview for Monofilament

The table below shows the grade line-up for monofilament. We offer a variety of copolymers with excellent transparency and tenacity, and super high-viscous homo polymer as well.

	Grade	Characteristics	Application
			Monofilament
Homo Super HV	1040A	Ultra-high viscosity for blow molding & monofilament	+++
6/66	2020A-8	Mid viscosity, CoPA for monofilament	+++
	2030A-8	High viscosity, CoPA for monofilament high performance	+++
	2320A	Mid viscosity, CoPA for monofilament	+++
	2420A	Mid viscosity, CoPA for monofilament higher transparency	+++
	2430A	High viscosity, CoPA for monofilament higher transparency with large diameter	+++
6/6T	2934A	Ultra-high viscosity, CoPA for monofilament high tenacity	+++
	2620A	Mid viscosity, Special CoPA for monofilament high tenacity	+++

+++ Particularly suitable

++ Suitable

+ Possible to use

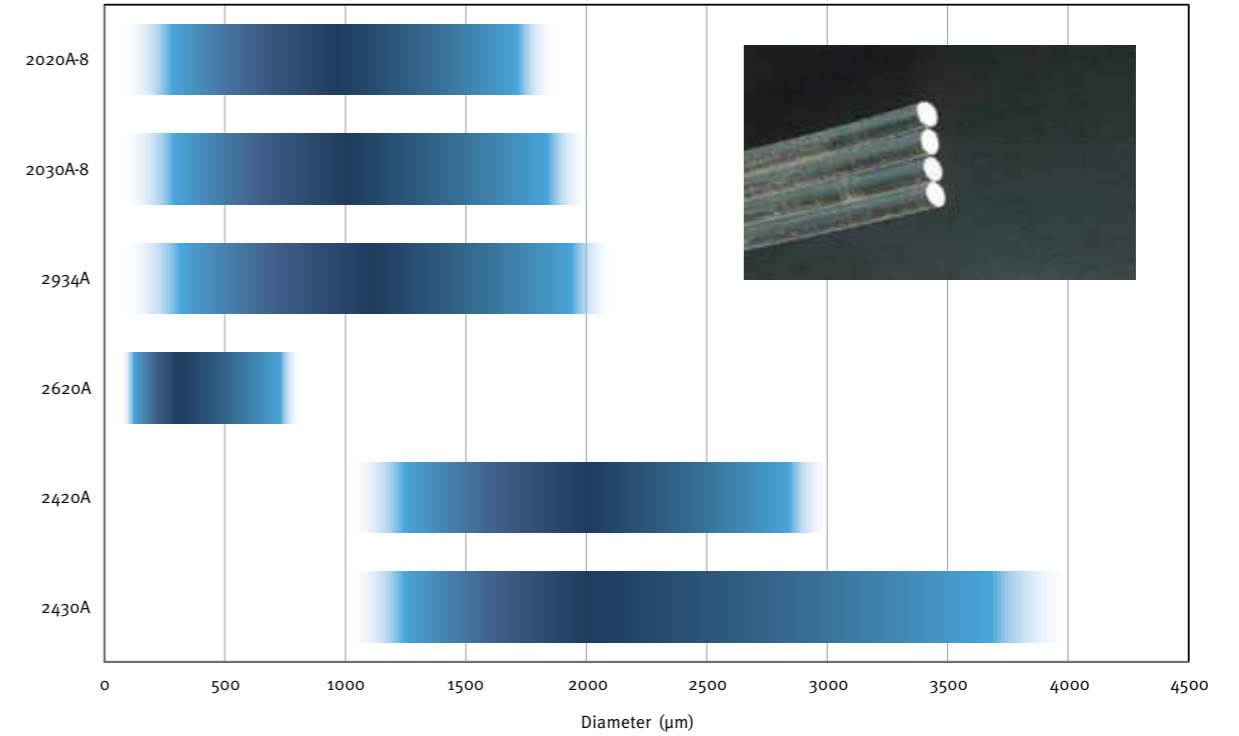
The table below shows material properties, typical drawing condition and properties of monofilament made of Novamid copolymer grades.

### Typical properties of monofilament made of Novamid

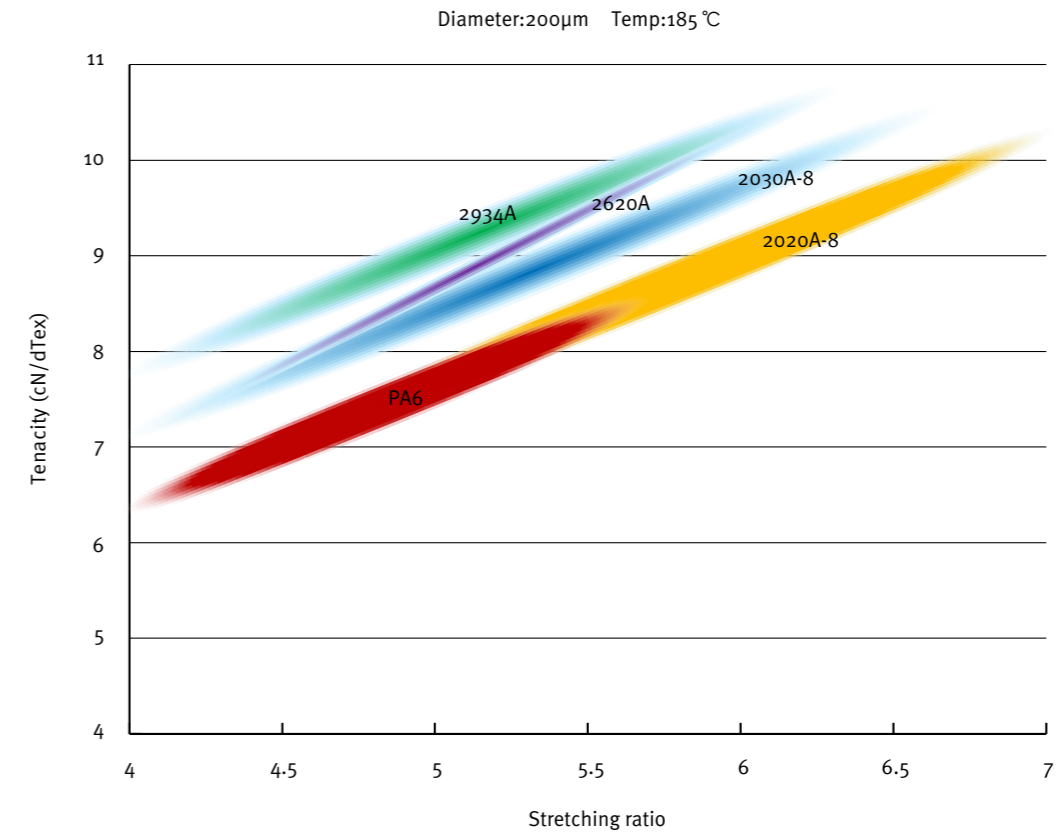
Properties	Test Method	Terms	Units	2620A	2320A	2020A-8	2030A-8	2934A	2430A	
<b>Properties of chip</b>										
Density	ISO 1183	-	g/cm <sup>3</sup>	1.14	1.14	1.13	1.13	1.13	1.13	
Water absorption	-	23°C, 50%RH	%	3.5	3.5	3.7	3.7	3.7	3.7	
Melting temperature	DSC method	-	°C	206	210	200	200	200	195	
Viscosity number	ISO 307	-	-	182	182	182	246	271	246	
Melt Mass-flow Rate	ISO 1133		g/10min	10	10	10	2.6	2.2	2.6	
Melt Volume-flow Rate			cm <sup>3</sup> /10min	9	9	9	2.3	2	2.3	
		Temperature	°C	230	230	230	230	230	230	
		Load	kg	2.16	2.16	2.16	2.16	2.16	2.16	
<b>Processing conditions of monofilament</b>										
Cylinder temp.		°C	C1 / C2 / C3 / D1 / D2				C1 / C2 / C3 / D1 / D2			
			240/250/250/250/250°C				240/260/260/255/255°C			
Nozzle Diameter			φ1.5		φ1.5	φ1.5	φ1.5	φ6.5		
Quenching Temp.		°C	10°C		10°C	10°C	10°C	15°C		
<b>1st stage drawing</b>										
Ratio		times	3.8	3.7	3.5	3.5	3.5	4.2		
Temp.		°C	95(wet)	100(wet)	100(wet)	100(wet)	100(wet)	100(wet)		
<b>2nd stage drawing</b>										
Ratio		times	1.7	1.7	1.71	1.71	1.71	1.4		
Temp.		°C	165(dry)	190(dry)	185(dry)	185(dry)	185(dry)	250(dry)		
<b>3rd stage / heat set</b>										
Ratio		times	0.95	0.98	0.95	0.95	0.95	0.95		
Temp.		°C	160(dry)	185(dry)	180(dry)	180(dry)	180(dry)	230(dry)		
<b>Properties of monofilament</b>										
Diameter		-	mm	0.24	0.24	0.24	0.24	0.24	2.2	
Deci-tex/Denier		-	dtex	4900	4900	4900	4900	4900	43300	
DRY	Tenacity	-	cN/dtex	9.5	7.2	7.3	8.8	10	7.2	
	Elongation		%	24	36	36	28	30	32	
	Young modulus		GPa	2.4	2.2	1.9	1.9	2.4	2.1	
	Knot tenacity		cN/dtex	8.5	6.2	6.9	7.8	9	5.3	
	Knot elongation		%	20	30	30	24	20	37	
WET	Tenacity	23°C, in water for 72hrs	cN/dtex	8.5	6.1	6.4	6.9	9.2	6.3	
	Elongation		%	31	42	38	33	31	47	
	Young modulus		GPa	1.6	1.3	1.2	1.6	1.6	1	
	Knot tenacity		cN/dtex	7.5	5.2	6.2	6.6	8	4.1	
	Knot elongation		%	25	32	34	30	25	35	

You could choose a suitable grade depending on the diameter of monofilament. Copolymer can be stretched at higher ratio than homo polymer in general which leads to higher tenacity. Specialty grades such as 2620A and 2934A can perform even higher tenacity.

### Suitable diameter range of monofilament per Novamid grades



### Tenacity vs Stretching ratio



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