DIAMOND DIES

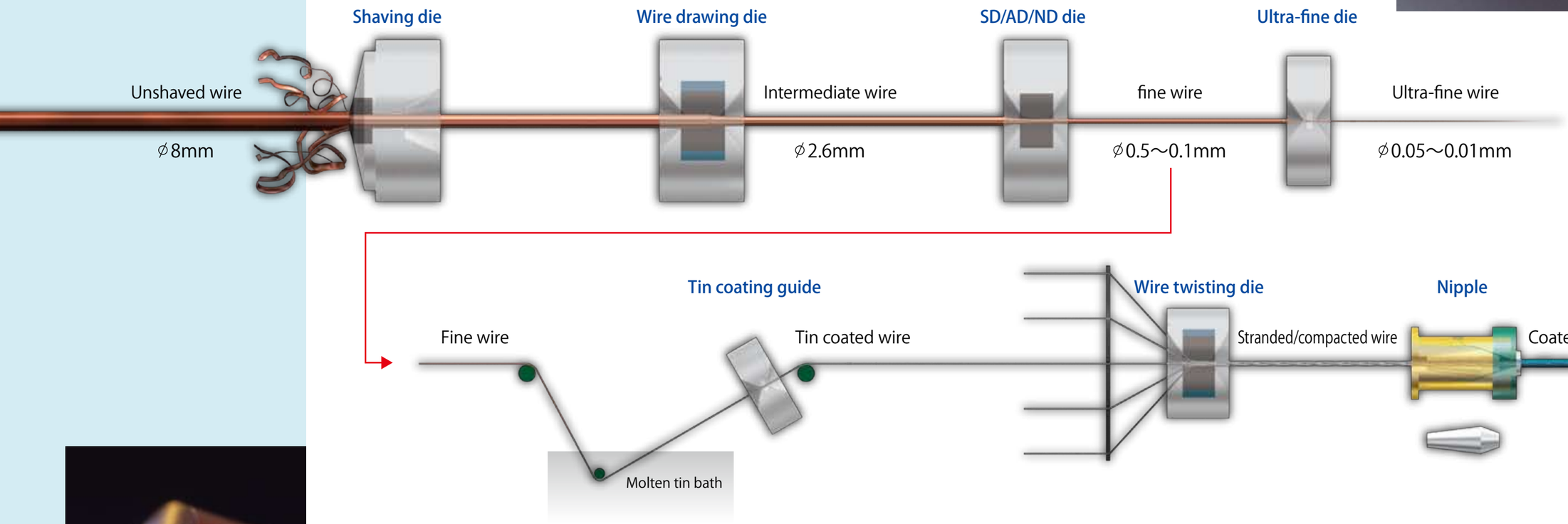
Creating stronger, finer and higher-quality wires

Diamond dies are used for precision drawing of various metal wires. We provide products that satisfy our customers' growing demands for precision and performance by using the rich know-how Asahi Diamond has accumulated over many years, by assuring high quality using state-of-the-art technology, and by making sure to confirm the following five points all the time.

《Five points to be confirmed》

1. Selection of correct types of raw diamonds
2. Proper die hole profile according to wire materials
3. Strict compliance with size and circularity tolerances
4. Satisfactory mirror polishing of die hole surfaces
5. Firm and accurate mounting

Manufacturing process (e.g., electric wire industry)



■Type and applicable diameter range of raw diamond material

Type	Applicable diameter range	
Single crystal diamond	ND: 0.008～2.0mm	AD: 0.008～1.5mm
Sintered diamond	SD: 0.04～30.0mm	

■Comparison of characteristics among different raw diamond materials

Type	ND die	AD die	SD die	WC die
Type of raw material	Natural diamond	Synthetic single crystal diamond	Sintered diamond	Cemented carbide (used as die material)
Hardness (Knoop hardness) (HK)	9,000～12,000	8,000～10,000	6,000～8,000	1,700～1,800
Bending Strength (GPa)	2.0	2.0	1.8	1.8
Compressive Strength (GPa)	8.5	8.5	7.3	6.1
Young's modulus (GPa)	990	990	880	630
Thermal conductivity※ (W/m·K)	700～920	1,260～1,670	130～210	70～80

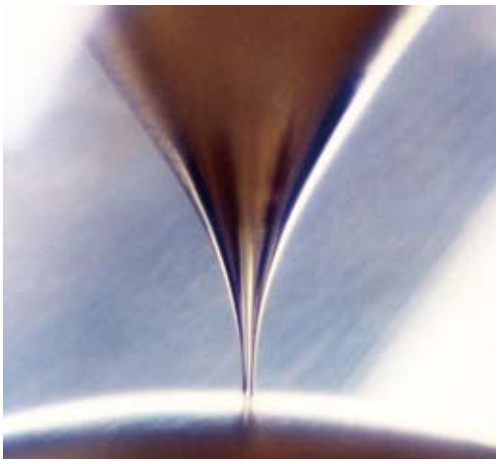
※) Under a temperature range between room temperature and 100°C

Single crystal diamond dies

Single crystal diamond dies

Single crystal diamond dies are often used for creating ultra-fine wires that must meet strict dimensional precision or for drawing wire materials that require high surface quality. The applicable diameter ranges are approximately 0.008–2.0 mm for ND and 0.008–1.5 mm for AD.

We fabricated ultra-fine dies, which must be equipped with a high-quality die hole surface, using Asahi Diamond's know-how on a mirror-polishing method.



Cross section (along the length of die hole) of a single crystal diamond die

■Single crystal diamond dies (standard sizes)

Nominal diameter (mm)	Maximum diameter of repairable wire (mm)
0.01~0.05	0.19
0.06~0.09	0.29
0.10~0.29	0.39
0.30~0.39	0.49
0.40~0.49	0.59
0.50~0.59	0.69
0.60~0.69	0.79
0.70~0.79	0.89
0.80~0.89	1.09
0.90~1.09	1.29
1.10~1.29	1.39
1.30~1.39	1.59
1.40~1.59	1.79

Note. The maximum diameters of repairable wires listed are rough estimates and the diameters of actual wires to be repaired may not match these values due to such factors as wear conditions of the wires.

Sintered diamond dies

Sintered diamond dies consist of a material resulting from sintering diamond powder under ultra-high pressure.
They are often used to maintain the high quality of drawn wires. They are applicable to wires with a diameter between 0.04 and 30.0 mm.

Sintered diamond dies

Cross section (along the length of die hole) of a sintered diamond die

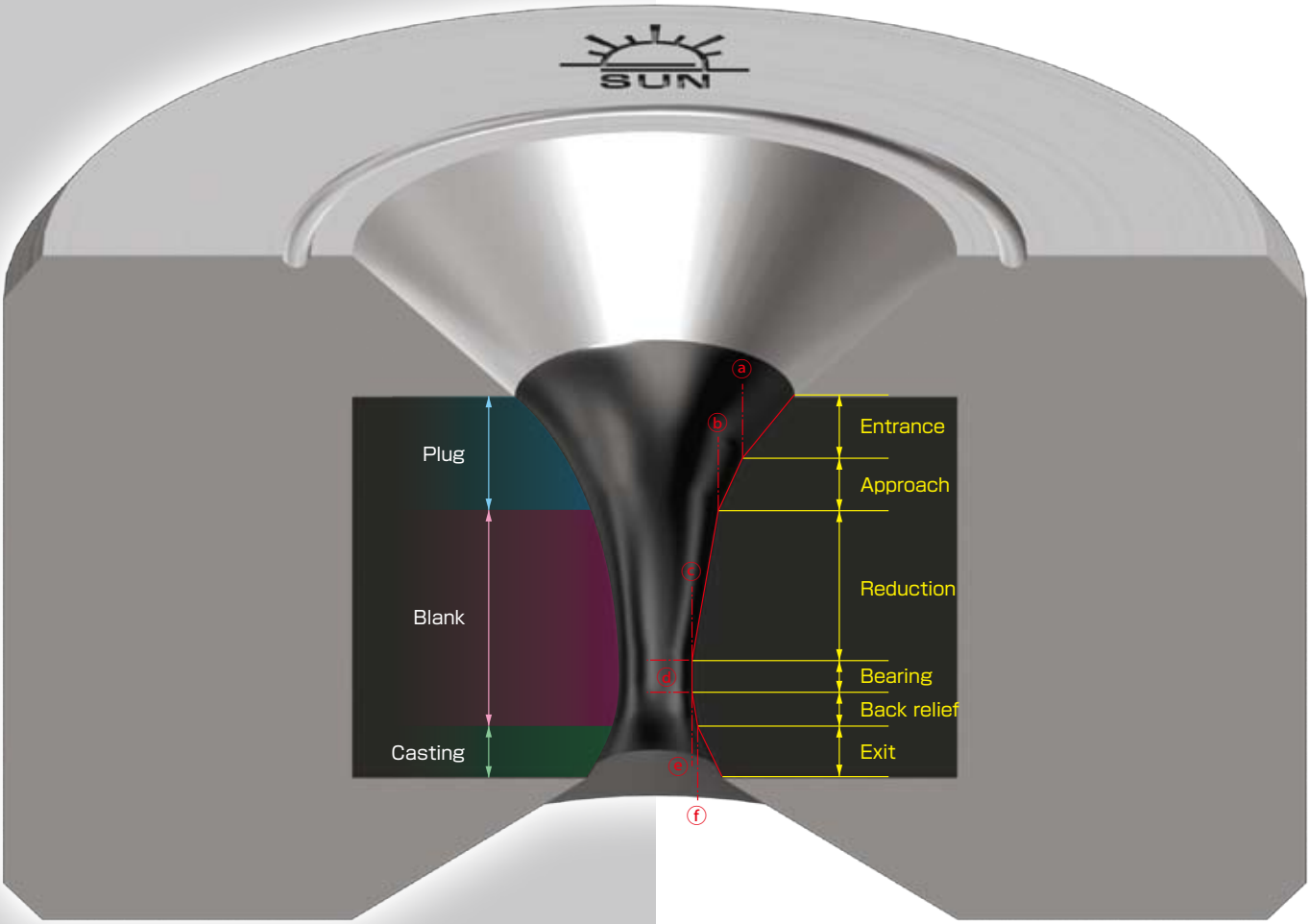
These dies are frequently used to process large-diameter wires, are not wear-resistant, and are free of directional cleavage. Consequently, they wear evenly and tend to be resistant to chipping and cracking.

■Sintered diamond dies (standard sizes)

Nominal diameter (mm))	Sintered diamond		Support ring	ADDMA No.※1	Maximum diameter of repairable wire (mm)
	Diameter (mm)	Thickness (mm)			
0.1～0.5	2.5	1.0	Unused	D6	0.5
0.1～1.0	3.0	1.5		D12	1.0
0.2～1.5	5.0	2.5		D15	1.5
0.4～2.0	5.0	3.5		D18	2.0
0.1～0.8	1.5	1.5	Used	D12	0.8
0.2～1.8	4.0	2.3		D15	1.8
0.4～2.3	4.0	2.9		D18	2.3
1.6～3.5	7.0	4.0		D21	3.5
2.3～4.6	7.0	5.3		D24	4.6

Note 1. When hard wires are processed, their diameters should not exceed 70% of the maximum diameters of repairable wires listed above.
Note 2. The maximum diameters of repairable wires listed are rough estimates and the diameters of actual wires to be repaired may not match these values due to such factors as wear conditions of the wires.
*1 ADDMA: American Diamond Die Manufactures Association

《Internal parts of a die》



■Profile of a die's internal parts

Measurement	Angle or length
ⓐ Entrance angle (˚)	70˚ ± 20˚
ⓑ Approach angle (˚)	40˚ ± 10˚
ⓒ Reduction angle (˚)	8˚ ～ 18˚
ⓓ Bearing length (%D)	20 ～ 70%
ⓔ Back relief angle (˚)	20˚ ± 10˚
ⓕ Exit angle (˚)	50˚ ± 20˚

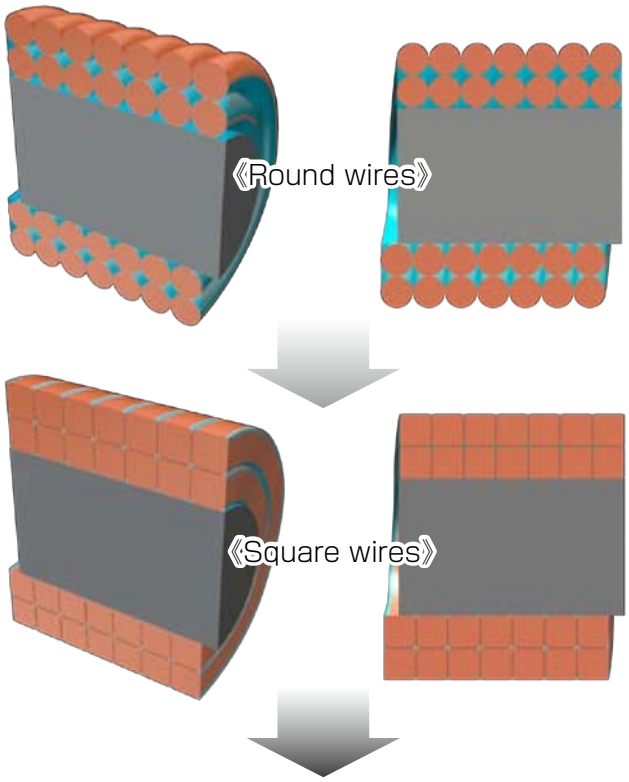
■Standard tolerance of wire drawing dies set by Asahi Diamond

Die size (mm)	IDAS※1(μm)	Asahi Diamond (μm)	Standard die case (mm)
≤0.013	4%D	2%D	25×6
≤0.18	3%D	2%D	
≤0.050	2%D	1%D	
≤0.150	1	0.5	
≤0.30	1.5	1	25×8
≤1.00	2	1	25×10
≤3.00	3	2	30×15
≤6.00	5	3	42×20
≤8.00	8	5	55×24
≤10.00	10	8	

Note. Please contact us for inquiries regarding die sizes and tolerance ranges different from those listed above.
*1 IDAS: Industrial Diamond Association Standards

Shaped dies

Asahi Diamond's shaped dies, equipped with sintered diamond, have earned a good reputation from our customers as the dies have enabled consistent manufacturing of high-quality shaped wires (i.e., wires with non-circular cross sections). Cross-sectional profiles of typical shaped dies are shown on the right side of this page. Shaped wires are used, for example, in connector pins and transformers for office automation equipment. The coiling of rectangular wires yields a higher space factor (higher density) compared to the coiling of round wires, leading to the generation of stronger magnetic force. So, the use of rectangular wires enables weight and volume reduction in motors and transformers. Due to this discovery, shaped wires are attracting much attention in recent years for their applicability in a wide range of fields including electronic and audio devices.

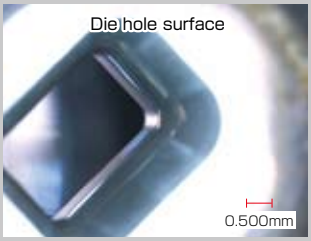


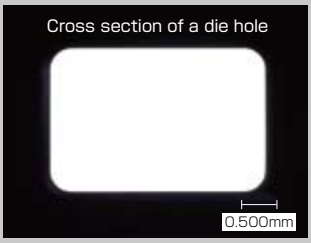
Increased space factor

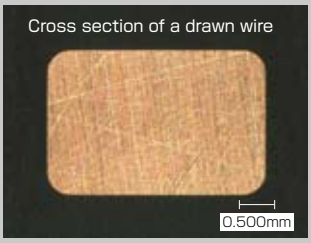
■Size range of shaped dies

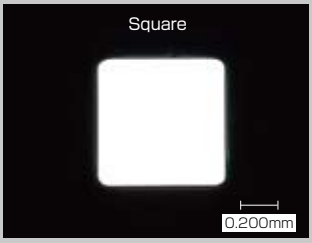
Shape of die		Dimensional limit		Tolerance (μm)
		Min. (mm)	Max. (mm)	
Square	A	0.10	10	10
	R	0.02	1	—
Rectangle	W	0.5	10	10
	H	0.20	1	10
	R	0.02	0.3	—

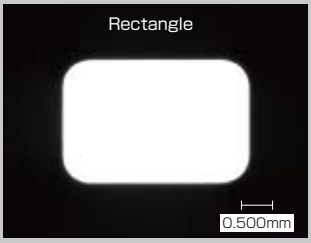
Note 1. Please contact us for inquiries regarding die shapes different from those listed above.
Note 2. Regarding rectangular dies, we normally handle a range of hole dimensions that comply with a formula: the long side divided by the short side ≤15.

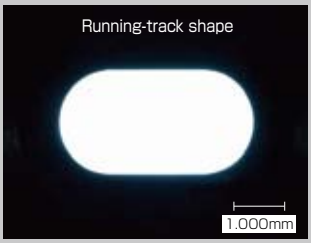


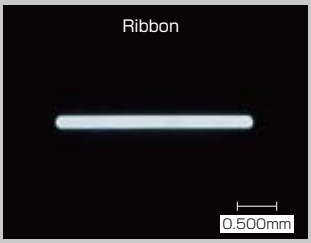












Characteristics

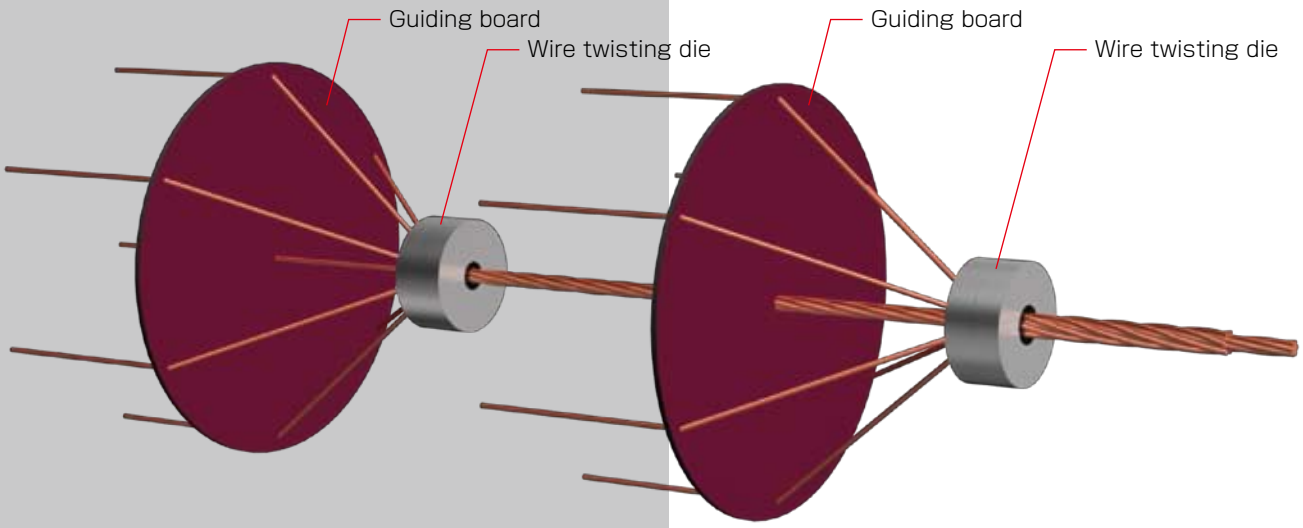
(1) These dies enable creating superior wire surface conditions compared to a rolling method
(2) Their holes can be adjusted to non-square shapes
(3) They are compatible with different kinds of materials to be drawn

Compacting dies

In combination with wire twisting dies, which twist many wires together, compacting dies close the gaps between wires by exerting external force. The resulting strand wires are used as power line cables, wiring harnesses for automobiles, wire ropes, and for other purposes.

Wire twisting dies

Cross section of wire twisting dies



Shaving dies

If defects are found on the wire surface and they may cause damage to the performance of final products, shaving dies are used to remove (shave off) them.

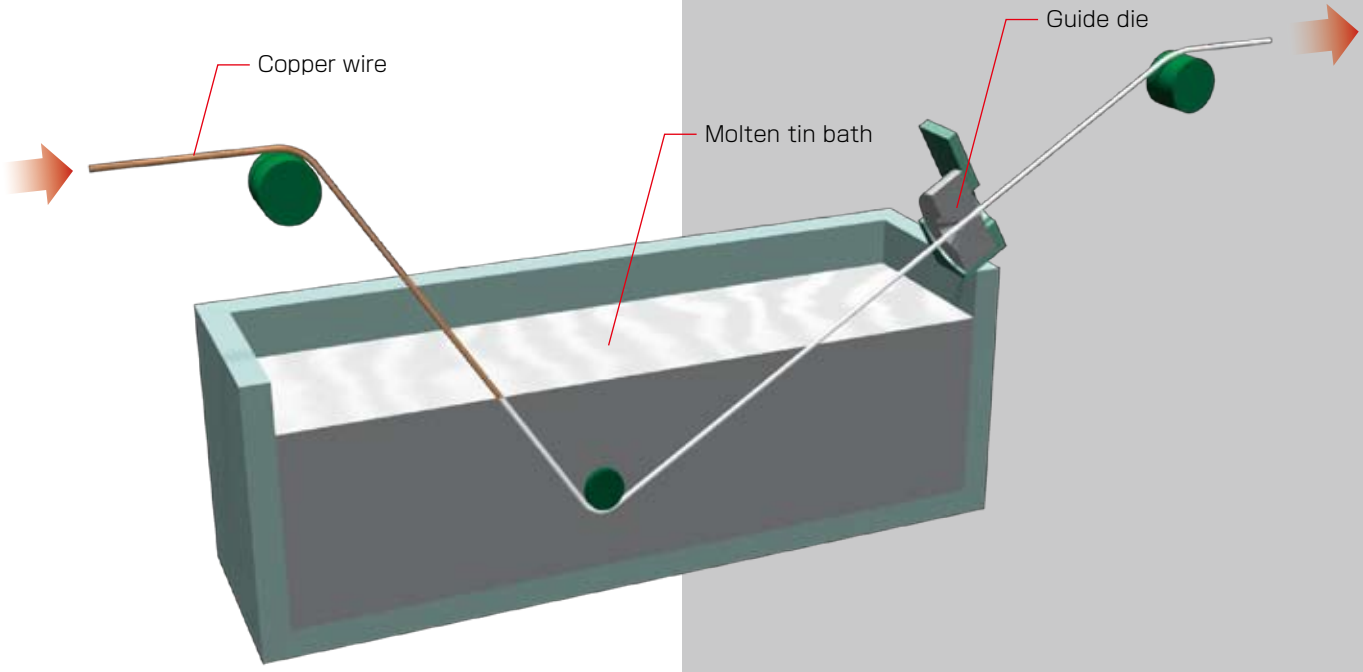
Characteristics

- Because these dies have a long lifespan, they enable shorter preparation time and reduce the amount of wasted wire materials
- The lifespan of these dies is 50 to 100 times longer than that of dies made of cemented carbide
- These dies can shave wires to give them superior surface conditions

Shaving dies

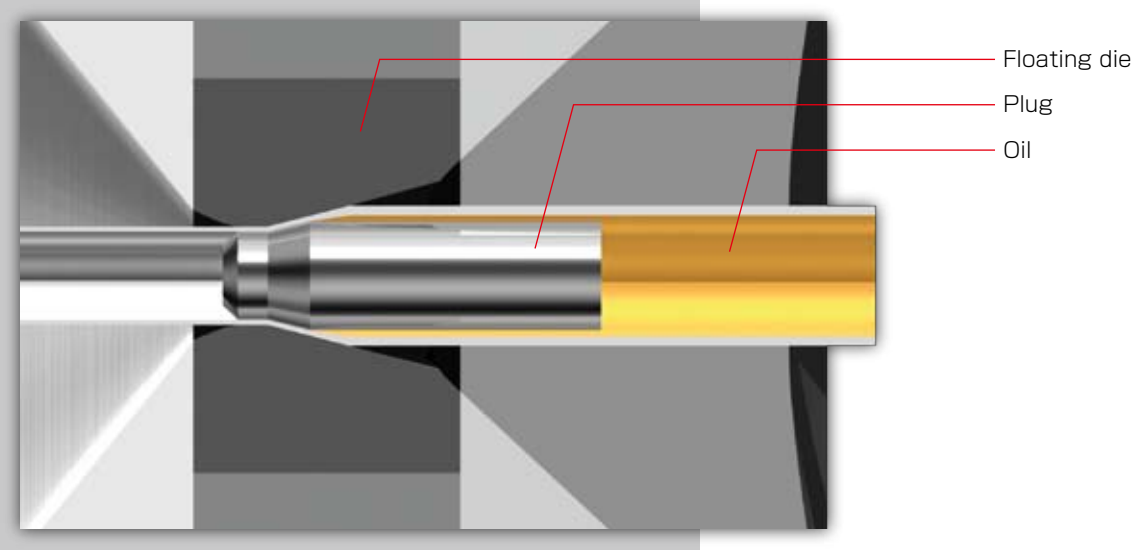
Tin coating guide dies

A copper wire gets coated with a layer of tin as it passes through a molten tin bath. Then, a tin coating guide die controls the thickness of the tin coating by pressing it as the coated wire is pulled through the die. Because copper wire is washed in an acid solution before the coating process, as the wire goes through the guide die, the die comes into contact with acid. This leads to the corrosion of the sintered metal and the metal frame on which the diamond is mounted. To prevent this, the guide die is generally reinforced with a corrosion-resistant titanium frame. Because titanium has poor wettability with molten tin, tin does not stick to the die frame easily. In addition, because titanium has lower specific gravity than tin, if the guide die accidentally falls into the molten tin bath, it conveniently floats to the surface and can be easily picked up.



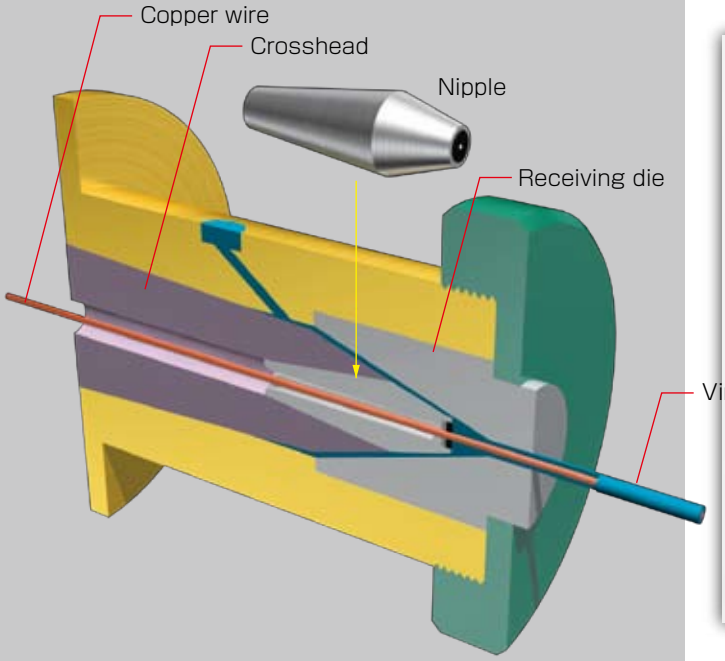
Sinking dies/floating dies

In a tube drawing process, a plug is inserted into a tube as a means to reduce the diameter of the tube in the same manner that dies are used to reduce the diameter of wires and round bars. The method to reduce only the outer diameter of tubes is called “sinking,” and this can be achieved using sinking dies. This method does not change the wall thickness of tubes, but deteriorates the tubes’ internal surface conditions. However, the tube drawing process can be enhanced by inserting a metal bar called a floating plug into the die. This process is called floating-plug drawing and it involves a floating die. Through this procedure, superior conditions are created both on the inner and outer surfaces of tubes. The floating-plug drawing process is primarily used to draw fine and long tubes.



Nipples (used with extrusion machines)

Nipples are tools to guide metal wires, such as copper and aluminum wires, as they get coated with resin after passing through wire-drawing dies. There are generally two types of nipples as extrusion machines have different head shapes: an axially aligned type with screw thread and a bullet-shaped non-axially aligned type. The tip angle and tip diameter of nipples vary in relation to the hole shape of receiving dies, which apply resin to an incoming wire, and in relation to the diameter of wires to be coated. As well as a single-core type, we also manufacture a multicore type and specially-shaped outer frames.



Diamond wire guides used with wire-cut electrical discharge machines

The accuracy of wire guides largely determines the precision of wire electrical discharge machining used in metal forming processes by various industries including die manufacturers. In collaboration with electrical discharge machine manufacturers, Asahi Diamond is among the first die manufacturers to develop diamond wire guides contributing to precision machining.

Diamond ultra high pressure water jet nozzles

Diamond water-jet nozzles were produced using the know-how we accumulated about wire-drawing dies. As diamond is incorporated into these nozzles, they can produce very narrow water flow which travels in a straight line under ultra-high pressure. The nozzles have a long lifespan and serve as precision cutting tools. By increasing the width of water flow, they are commonly used for washing automobiles and parts of electrical devices as well as for deburring.

Flat diffusion nozzles for high-pressure washing and surface treatment

Spray patterns

《Spray angle: 15˚》

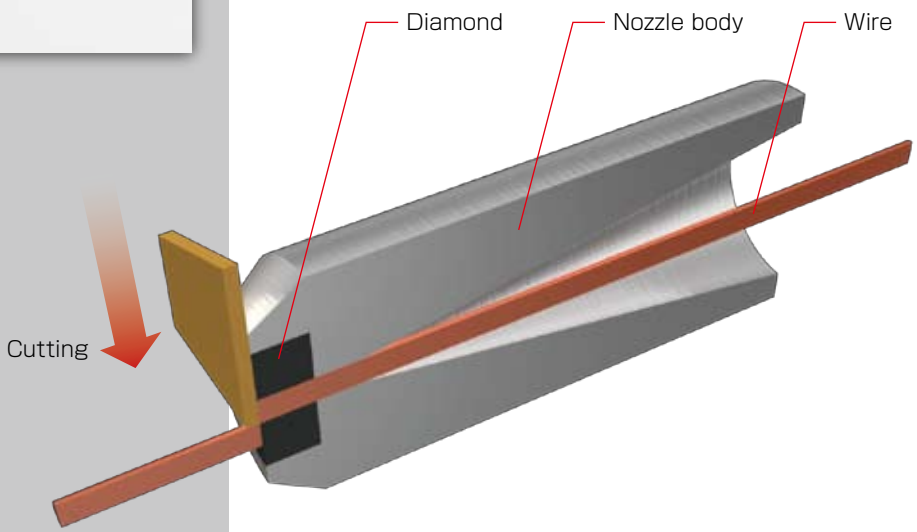
《Spray angle: 7˚》

Hollow centers

Hollow centers hold a workpiece in place during lathe turning or cylindrical body processing. Very hard and wear resistant, Asahi Diamond's hollow centers enable creating cylindrical products with a precision equivalent to circularity of less than 1 μm.

Nozzle cutters

Nozzle cutters are used to cut electronic component (e.g., terminals and switch contact parts) materials. Asahi Diamond's PCD nozzle cutters have excellent cutting quality and a long lifespan. Material yield associated with them is higher than that associated with circular saws, and the quality of cut surfaces produced by PCD nozzle cutters is superior to that produced by cemented carbide nozzles.



INFORMATION

《Precautionary notes on handling of dies》

1. Set dies correctly.

- Correctly set dies in die holders.
- Very carefully pass a wire through dies so that it makes a straight line. Neglecting to do so may lead to the production of low-quality drawn wires or abnormal wearing of dies.

2. Use a lubricant.

- The use of lubricants greatly enhances work efficiency, the surface finish of wires, and the lifespan of dies.
- Insufficient use of lubricants may cause damage to dies and yield wires with non-lustrous surfaces.
- Keep lubricants clean all the time.

3. Handle dies gently.

- Do not apply impact to dies; do not make them bump into hard objects; and do not handle them roughly.

4. Repair damaged dies as soon as possible.

- The lifespan of damaged dies can be extended by repairing them when the damage/wear is still minimal.
- In general, the surface roughness of drawn wires indicates the conditions of the dies used—if the wire surface is rough, it is likely that the inner surface of the die is also rough.
- We recommend users to frequently and carefully inspect surface conditions of drawn wires to determine the proper timing of die repair.
- Avoid excessive use of dies, as such practice will roughen the surface of drawn wires and make the back relief susceptible to damage caused by fine metal powder adhering to the dies.

《Ordering our die products》

Please provide us with the following information.

1) Die hole diameter (size)
2) Allowable size (tolerance)
3) Type of wire material to be drawn
4) Size of base wire
5) Case size
   Please refer to the table titled “Standard tolerance of wire drawing dies set by Asahi Diamond” on page 5 in this catalog.
6) Type of case
   Stainless/titanium

* Please contact us regarding special specifications.

R & D

Evaluation system

To ensure the provision of high-quality products to our customers, we thoroughly evaluate our products.

Die profiler

Measuring the shape of die holes

Microscope

Measuring the shape of die holes and observing the quality of die hole surfaces

mg measuring instrument

Estimating the diameter of a drawn wire based on its weight measured

Electronic micrometer

The device is capable of making measurements at a resolution one order of magnitude higher than conventional electronic micrometers

Laser scan micrometer

The device is capable of measuring the diameter of a drawn wire without contacting the wire

Circularity measuring instrument

The device is capable of measuring the circularity of a drawn wire without contacting the wire

Future-oriented research and development

"We offer needs-based products" —— that is the theme behind our R&D.

Scanning electron microscope

Observing the quality of die hole surfaces and measuring physical properties of wire materials

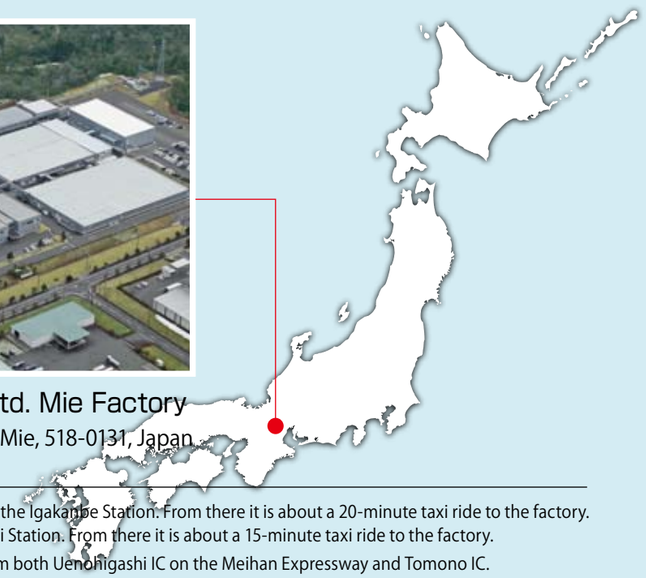
We always collect up-to-date information on the wire-drawing industry, use the latest technologies such as the systems and devices shown on this and previous pages, and engage in R&D activities in order to provide or recommend products that meet the needs of our customers.

《Diamond die manufacturing base》

Asahi Diamond Industrial Co.,Ltd. Mie Factory

〒518—0131　7-8-1, Yumegaoka, Iga-shi, Mie, 518-0131, Japan

Site area：127,960 ㎡



By train : If taking the Kintetsu Osaka Line, get off at the Igakambe Station. From there it is about a 20-minute taxi ride to the factory.
If taking the Iga Line, get off at the Uenoshi Station. From there it is about a 15-minute taxi ride to the factory.

By car : About a 10-minute drive to the factory from both Uenohigashi IC on the Meihan Expressway and Tomono IC.

I.D.A.会員

Asahi Diamond Industrial Co., Ltd.
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QMS, EMS CERTIFIED FIRM
ISO 9001 :JCQA-0096
ISO 14001:JCQA-E-0530
Mie Factory

Shape the Innovation
私達の革新で、お客様の革新をカタチにする

2016.8.1,000