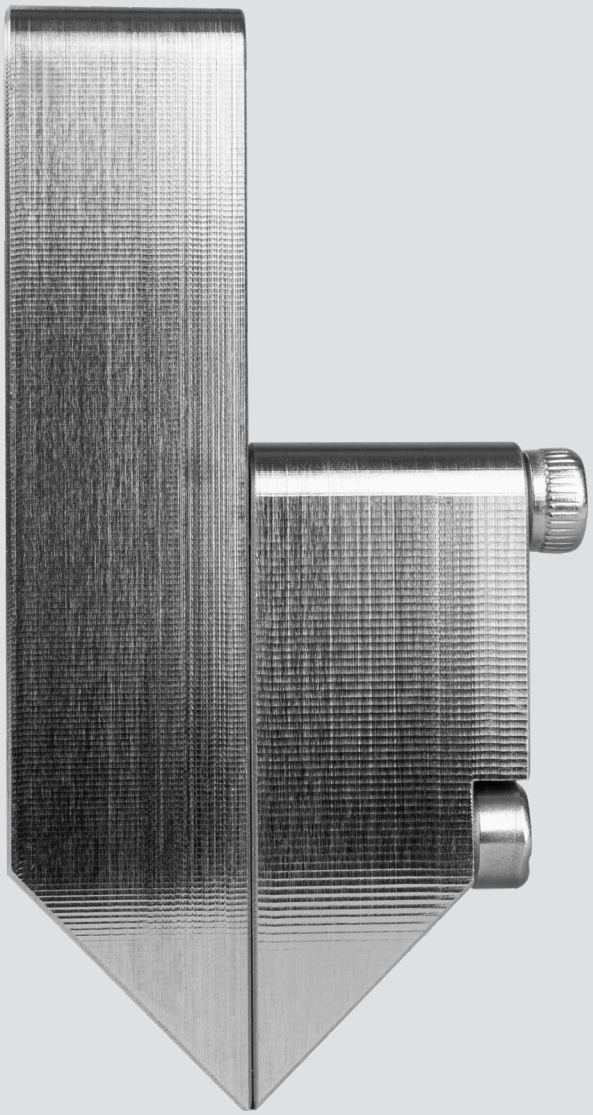
SLOT-DIE HEADS



OPV infinity

Slot-die Heads

infinityPV offers designed slot-die heads from the very small to the very large in a wide range of materials with different levels of precision and different functionalities such as heating/cooling, agitation and high/low viscosity ranges.

All our slot-die heads require fitting kits and shim kits to operate. The small laboratory scale heads are available in a number of materials and standard widths of 40 mm, 65 mm, 115 mm, 165 mm, 195 mm and 305 mm allowing for working widths of a single 10 mm or 13 mm stripe, 50 mm, 100 mm, 150 mm, 180 mm and 280 mm respectively.

We always have standard heads and shim kits in stock, and we make custom shims from day-to-day as a service to our clients. In addition, we can always make the slot-die head and shim kits according to your needs.

The dead volume for the laboratory slot-die coating heads ranges from hundreds of micro-liters to a few milliliters. Our larger pilot and industrial scale slot-die heads have a large dead volume starting from around 0.5-2 mL pr cm of coating width. This implies that our range of coating heads for coating to a full width of 304.8 mm have a dead volume of approx. 15-60 mL.

The slot-die heads intended for operation at low pressure with low viscosity inks are comprised of only two parts which greatly simplify assembly, disassembly, and cleaning. They can be operated with a single shim or with a shim kit comprising shim and meniscus guide for coating stripes at low web speeds (0.1-5 m min^{-1}). The light-weight PEEK heads allow for ultrafast positioning on automated coating platforms.

Key Highlights

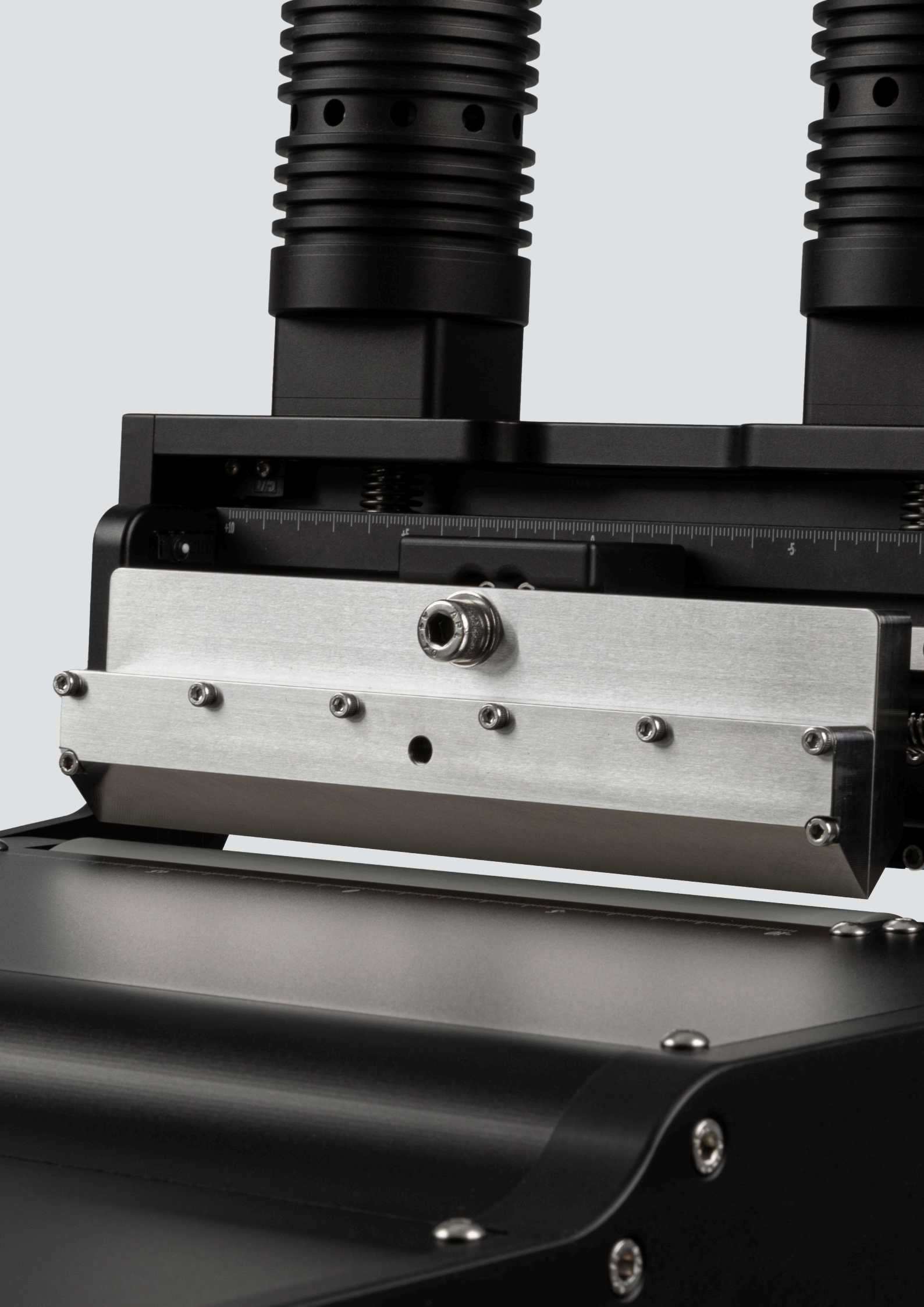
- Available in PEEK, Stainless Steel and Titanium
- Available in Widths of 40 mm, 65 mm, 115 mm, 165 mm, 195 mm and 305 mm
- Light Weight
- Very Simple to Assemble and Disassemble
- Easy to Clean and Maintain
- No Gaskets
- Few Parts
- Low Cost
- Available with Electrical Heating
- Fits all Our Coating and Printing Platforms
- From Single Stripes to Many
- From Narrow to Wide Width
- Easy Design of Shims and Meniscus Guides
- Very Low Dead Volume is Possible
- Temperature Controller for Heated Slot-die Heads is Available Integrated in the Machine or as a Stand-alone Unit

Tips for Selecting a Slot-Die Head

Selecting the right slot-die head involves considering various options and decisions. To guide you through this process, we've compiled a list of questions. Please review them and answer them as well as you can to ensure that you choose the most suitable product for your needs.

- Are you coating at high speed (>2 m min^{-1}) or low speed (< 2 m min^{-1})?
- Is your ink material high viscosity (>100 mPas) or low viscosity (0.6-100 mPas)?
- Does your ink exhibit Newtonian, thixotropic or rheopexic behavior?
- Do you need to pump ink at high pressure?
- Is your ink homogenous or inhomogenous (i.e. it contains particles)?
- If it contains particles, are they magnetic?
- Is the chemistry of your ink mild (i.e. organic solvents) or extreme (i.e. strongly corrosive or redox active)?
- Is your ink very costly or is it available in volume?
- Do you need to coat lines, or do you need to apply an even coat over the entire working width?
- What coated width do you need (working width)?
- Do you have geometrical constraints surrounding your coating platform (i.e. inverted coating or narrow space)?
- Do you need to heat or cool your ink during coating?
- Do you need constant agitation of your ink to maintain homogeneity?
- Do you have a requirement for very high precision?
- Is the budget for your application limited?
- Do you need a general-purpose multiple use slot-die head, or will it be dedicated to one process and only one ink?

By answering these questions, you'll discover that decisions regarding materials, dead volume, feed ports, connections, lip design, precision, special functions, and more have already been addressed. Generally, our budget-friendly option will meet your requirements, but occasionally, there may be situations where low-cost solutions are not available.



Choice of Material

We are often asked about the arbitrarily set limit between high and low speed. The 2 m min^{-1} threshold is a practically chosen limit where coating quality at lower coating speeds demonstrate little dependence on cavity design, feed ports and surface precision and quality whereas a relatively sharp lip design and use of adjuvant tools such as a meniscus guide when coating stripes is important at low speeds.

This implies that a cost competitive stainless slot-die head and shim/guide combination will solve >90% of the common coating tasks. There are of course the special cases of particle suspension coating, coating at high ink pressure, coating at elevated (or lower) temperatures and extreme chemistry. In these cases, the materials choice and design of the head becomes critical.

Our budget heads employ stainless steel M315 (yielding longer tool life and making manufacture and precision surface grinding cost efficient). This material is also quite corrosion resistant. Up the ladder, we find more difficult to handle materials such as the well-known stainless steel 316L which exhibit excellent corrosion, mechanical and thermal resistance at the expense of being more difficult to machine. It also exhibits a high density.

When chemistry becomes extreme, we offer slot-die heads in grade 2 titanium for extremely acidic or oxidizing environments. For strongly reducing or very basic environments we offer slot die heads in PEEK. Titanium slot-die heads are also mechanically robust and light weight. PEEK slot-die heads are extremely light weight but more easily subject to mechanical wear.

Size Comparison

40 mm Head (10/13 mm Working Width)

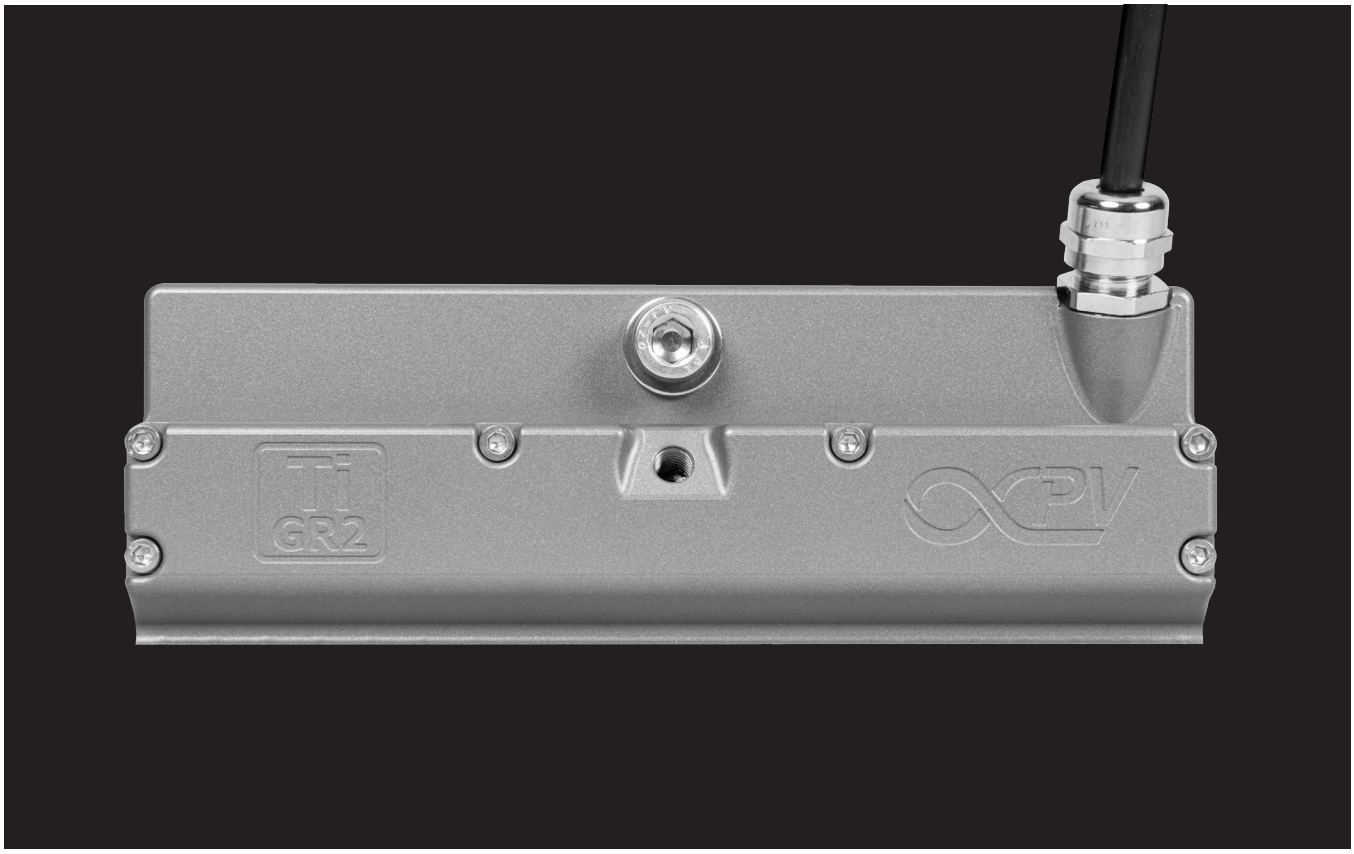
65 mm Head (50 mm Working Width)

115 mm Head (100 mm Working Width)

165 mm Head (150 mm Working Width)

195 mm Head (180 mm Working Width)

305 mm Head (280 mm Working Width)



Optimizing Ink Distribution with Slot-Die Head Technology

As ink enters the slot-die head, the first contact is the feed port. The feed port is optimized to be as unobstructive to flow as possible with little or no added dead volume. We take long strides to make the feed port a natural extension of the feed hose inducing as little cavitation as possible. As a result, we offer several inlet ports, hose diameters and connector types.

The next environment that the ink experiences is the inside cavity of the slot-die head where ink is distributed across the width of the head with as little resistance to flow as possible. The ink then passes between the two faces of the slot-die head in the slot and here the surface quality is highly critical. The inside of our heads are precision ground offering the smoothest and most even resistance to flow across the width of the slot-die head. The largest pressure drop should be in this part of the head, and it is therefore also of outmost importance that the pressure drop is as even as possible.

Over time, these surfaces can become scratched or worn and this can be reground. In most cases where a meniscus guide is used this problem can be eliminated since the ink now flows against the surfaces of the shim-kit material (back, middle and front). The materials we employ (stainless steel 316L and titanium grade 2) are ultra smooth. The economy solution that ensures a reliable result each time follows this approach and seeing that the guides are easily replaced at low cost, this is a very efficient approach.

Finally, the ink exits the slot and establishes an equilibrium between the lip of the head and the surface of the substrate that is coated when distributed across the width of the slot-die head (or guide). The lip design is a critical part of the head and your coating success. For low coating speeds, it is best if the lip is sharp. For higher coating speeds it is best if it is truncated by a few hundred microns or in some cases rounded. Our lip design is optimized for slow to medium speed (< 10 m min^{-1}) we offer custom lip design for high speed or special applications (i.e. curved lips or flat lips).

Heated Heads

There are several ways to heat slot-die heads – direct heating of the head pieces or a heated mount. The heated mount has the advantage of simplicity and that it works for any head.

A clear disadvantage of this approach is that heat transfer is most often poor (stainless steel, PEEK and titanium are very poor conductors of heat) and the temperature of your ink and head is unknown and uneven. We only recommend this approach for highly heat conducting alloy heads or small heads subject to marginal heating over ambient temperature and low flow rates (i.e. a 40 mm head operated at 40 °C with a flow rate of 0.1 mL min^{-1}).

Direct heating of the head pieces can be achieved with electrical heating or liquid heating/cooling. The former is the simple and the latter is the most complex but also the most performing. We offer all three solutions but generally find that direct electrical heating of the head pieces is the most performing in terms of cost, simplicity, and ease of use.

We offer side entry and top slanted entry of the electrical wiring/liquid hoses for the heating. In the standard configurations this is always from the right side of the heated head when viewed from the front in operation (as this fits our machine platforms best) but we can of course also supply with entry to the left or at specific points.

Slot-Die Head Selection Guide

We cover three standard materials: PEEK (ultra-light weight), stainless steels (M315/316L heavy) and titanium (light weight). We also offer various alloys (aluminium-magnesium) and have on occasion made heads in inconel and teflon. The table below is a selection guide for our range of slot-die heads.

	PEEK	M315 Stainless	316L Stainless	Titanium
40 mm head (10/13 mm working width)	✓	✓		
65 mm head (50 mm working width)	✓	✓	✓	✓
115 mm head (100 mm working width)	✓	✓	✓	✓
165 mm head (150 mm working width)	✓	✓	✓	✓
195 mm head (180 mm working width)	✓	✓	✓	✓
305 mm head (280 mm working width)			✓	✓
Heated 65 mm head (50 mm working width)	✓	✓	✓	✓
Heated 115 mm head (100 mm working width)	✓	✓	✓	✓
Heated 165 mm head (150 mm working width)	✓	✓	✓	✓
Heated 195 mm head (180 mm working width)	✓	✓	✓	✓
Light Weight	✓	✓	✓	✓
Heat Conducting		✓	✓	✓
Thermally Insulating	✓			
Low Heat Capacity	✓			
Corrosion Resistant	✓	✓	✓	✓
Precision Ground		✓	✓	✓
Cost	Medium	Low	High	High

Our History

Established in 2014 by CEO Frederik C. Krebs, infinityPV is a Danish company that has been steadfastly committed to printed electronics since its inception. Over time, our focus has naturally expanded to cover all aspects of advanced modern manufacture based on roll-to-roll processing that grants access to a large scaling potential for any given fixed size production platform. Our success is underpinned by a dedicated effort to maintain a low environmental footprint in both product development and manufacturing processes.

Our Knowledge

infinityPV is a high-tech company that centers on green transitioning and our in-depth knowledge base is centered on energy, chemistry, physics, mechanics, electronics, and software. We are extremely apt when it comes to inventiveness and development, which is what unifies the diverse workforce. We have applied our knowledge to make it a business to serve a market where there is typically only one customer – you. There is only one customer because the intricacy of your needs comes from your advanced research and our knowledge can help you run the extra mile or reach that extra goal.

A Company You Can Trust

Your needs are unique, and we almost certainly have material in stock that will grant you the fastest access to exactly what you need. We invite you to come to our production site and see for yourself before you engage in business with us. We guarantee customer satisfaction, and we are proud to say that we offer everlasting support to our existing clients and the products we make for them. We always have spare parts in stock or can make them quickly. We leave nobody behind.

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