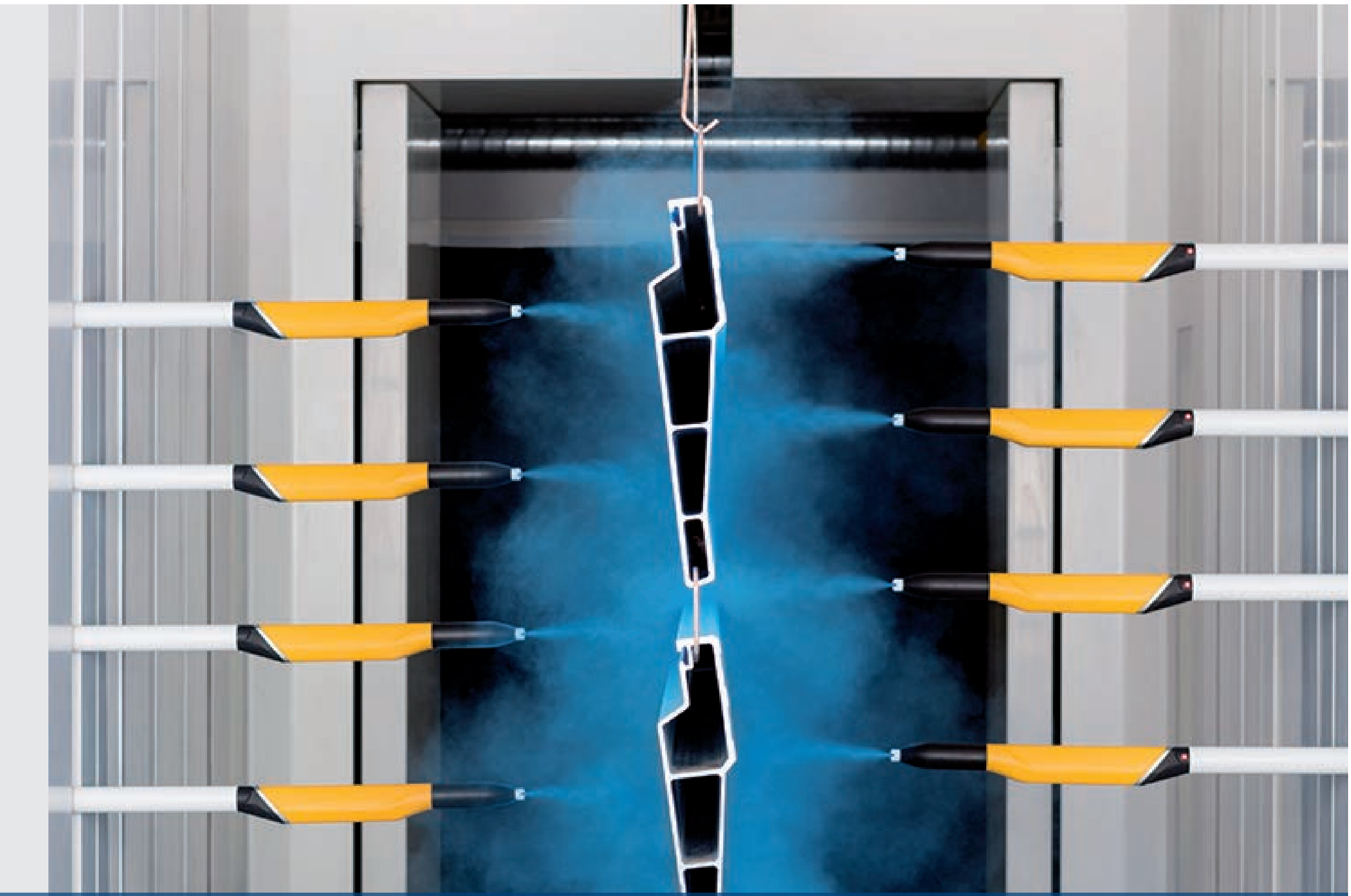

Consistent quality guaranteed thanks to new application technology

In electrostatic powder coating, the perfect combination of all application parameters is primarily responsible for stable and reproducible coating quality. Optimal settings for powder quantity, total air, high voltage and current strength condition the coating powder. This creates consistent, high-quality coating results with the desired coating thickness on the object. The latest application technology from Gema ensures that the powder is applied in the exact amount required and with the optimum charge. With this pioneering technology, GEMA once again sets a milestone in the powder coating industry.

A perfect surface coating depends not just on having a sophisticated application gun. Rather, there are interdependent and coordinated systems which provide good coating results. Modern powder coating offers customers an exciting variety of colors, textures and characteristics. This involves a large number of influencing factors which affect the coating result both prior to and during the application process. For an optimum result, it is therefore vital to use powder application technology which precisely regulates and controls all the factors, from powder fluidization to spraying.
We take a look at the application process below, without delving too deep into the physical phenomena of electrostatics, differentiating here between the three sub-processes of "delivery", "charging" and "atomization". Each sub-process must meet high requirements and at the same time function optimally when used in combination. When developing the latest application technology, Gema's focus was on achieving the perfect synergy of all parameters.

Everything starts with the right powder delivery

Virtually all types of powder available today are designed for a wide variety of applications. In order to be able to have the required powder characteristics, they must be processed as gently as possible within the coating process. The task of the transport technology is to supply the powder at its target location both in its original composition and with a defined and precise quantity.

Precision delivery is needed to deliver the powder from the fluidized powder hopper to the gun, guaranteeing stable and precisely adjustable delivery quantities at all times. In order for a perfect powder cloud to be able to form, the powder must be supplied to the nozzle of the gun at the right speed. Inhomogeneous powder-air mixtures or transport-related influences on the powder components result in measurable differences in the coating thickness distribution and the reproducibility of the coating results.
There are currently two powder transport technologies available in electrostatic powder coating. The first is injectors, which work according to the Venturi principle, and the other is dense-phase pumps, which push the powder through the powder hose by means of vacuum and pressure phases.
Dense-phase technology has the better arguments when it comes to maintaining a stable and precise powder delivery over relatively long production times in order to not just monitoring but also optimizing the subsequent processes of charging and atomization. Despite the good basic concept, the dense-phase method has in the past been unable to impress completely, as the technical implementation and handling was too complex. GEMA has taken its many years of experience and used it to develop the technology further. The result is the patent-pending application pump OptiSpray, a practice-oriented and economical system solution (figure 1).

If the powder transport technology is capable of maintaining constant and definable powder quantities, the expecations of uniform coating thicknesses, reproducibility, sustainable savings of powder and reduced wear on parts will be met. Whoever has the powder delivery under control will have the whole powder application mastered.

Figure 1: Application pump

Figure 2: Injector with optimized geometries for an extended service life

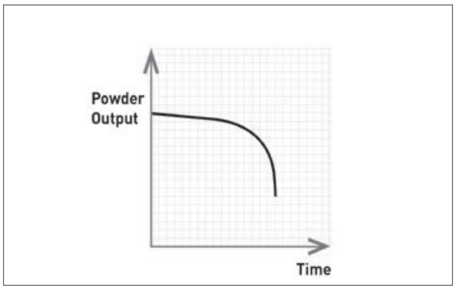

Figure 3: Typical injector curve

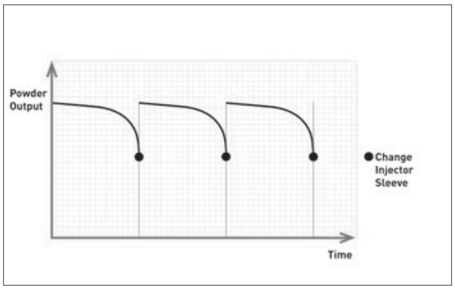

Figure 4: Stability of an injector over time

Injectors: reliable but prone to wear

The most widespread technology for powder delivery is based on injectors (figure 2), which suck the powder with a vacuum using the Venturi principle and transport it onwards through a hose. With injectors, the stability of the powder flow is strongly dependent on the condition of the internal components. On account of the physically-dependent higher speed of the air-powder mix, it causes an abrasive effect on the contact surfaces of the injector, reducing the flow over the course of time (figure 3). With an optimized selection of materials and optimized geometries, GEMA has enhanced the injector technology to such a point that a continuous powder stream and long maintenance intervals are achieved.

The negative effects of signs of wear can to a large extent be compensated by means of correction factors in the gun control. These corrective measures are based mainly on the individual experience of the wear behavior of the delivery technology used, however, which of course represents a major uncertainty component. There is nothing left but for the user to replace the worn part, the so-called injector sleeve, regularly (figure 4). This is done on average every two weeks in single-shift operation.

Application pump: fit for the future

The new OptiSpray application pump does not exhibit this wear behavior. The flow of powder remains stable and the amount of powder delivered also do not change over long periods of time (figure 5).

Figure 6 shows the superposition of figure 4 and 5, with the significant differences between the two powder delivery technologies. In order to maintain the powder discharge level necessary for the coating process, when using the injectors the actual powder delivery value must be higher than the nominal value over the entire life cycle of the injector sleeve. This increased amount of powder is problematic not only in relation to reproducible coating thicknesses, but generates unnecessary powder wastage, as well as additional maintenance. This results in a powder-saving potential, which is shown

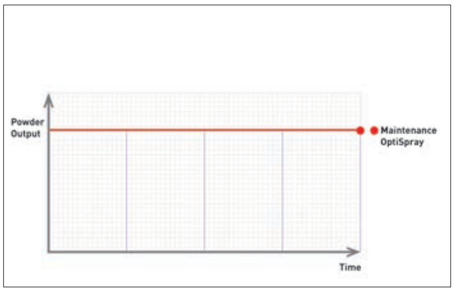

Figure 5: Stability of a dense-phase pump over time

by the shaded areas in figure 6. The pump application technology used in the OptiSpray exploits these savings potentials, thus sustainably reducing operating costs by saving powder and greatly reducing maintenance times.

Another important factor in achieving a stable flow of powder is the design of the suction line between the powder hopper and the delivery system. A powder hose that has been incorrectly routed is a very common fault. Long powder hoses and tight bending radii have a negative effect on homogeneous powder flow. A conceptually sophisticated integration of powder delivery technology to the powder hopper is therefore vital. The OptiSpray

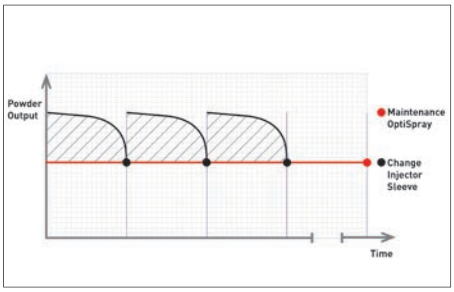

Figure 6: Powder savings and reduced maintenance intervals

application pumps are mounted on both sides of the powder hopper. This results in an extremely short and rigid suction line (figure 1 and figure 10). An additional fill-level sensor in the powder hopper ensures the level remains constant and thus ensures uniform suction conditions.

With the OptiSpray, a special focus was placed on an absolutely straight and break-free flow path inside the pump. The design ensures gentle transport of the powder, without changing the characteristics of the powder. Powder types which react sensitively, such as metallic or textured powders, will be protected during transport. They arrive at the atomizer in their original condition, can be processed more easily and thus produce better results. The deliberate separation of the powder suction intake from the powder hopper from the onwards transport to the application gun makes it possible to work with very long powder hoses, without any significant losses in the amount of powder delivery.

Optimizing charging efficiency using PCC mode

Each user has his own experience of what electrostatic capacity the powder should be charged with. To achieve the required coating quality, each powder can withstand only a specific amount of charge. With the increased use of so-called high-charge powders, new devices are needed which allow precise regulation of the current values to below 10 µA and which thus prevent overcharging of the powder.

When it comes to electrostatic charge, the prevailing view is "The more the better". In practice, the current value settings on the control units therefore tend to be too high, which results in an excess of free ions. This encourages the emergence of so-called «orange peel» pattern as a result of back ionization effects, involves a reduction in transfer efficiency or limits the powder coverage of recesses in the case of complex parts. To avoid or at least reduce this, the current flow through the workpiece must be reduced. In practice, the free ions are discharged via an earthed component, which can be mounted on the gun. The free ions follow the shortest path to an earthed object. But in the case of complex coating objects, the gun tip can be directed to close to the coating surface, and the free ions discharge at the wrong location. The use of this simple measure is accordingly limited. Here, the modern gun control offers the option to work at constant current levels. This means that the voltage automatically adjusts relative to the distance of the component. This enables coating at ideal current values, regardless of the distance to the part, and prevents an excessive number of free ions.

At this point the question arises of what the ideal charge is for powder coating. Coating powder can in practice roughly be grouped into three types of charge (figure 7). The so-called high-charge powder varieties of charge type A primarily include metallic and enamel powders or powders for two coat / one fire applications (also known as dry-on-dry process). For this powder, a charging current in the region of up to 10 µA is sufficient. Depending on the specification, standard powders (polyester-epoxy, epoxy) belong to categories B and C and achieve their ideal charge at higher current levels.

In the charging process for high-charge powders (charge type A), it is clear that currents below 10 µA are already sufficient to achieve maximum application efficiency and the best surface finish. The described approach of overcharging the powder should be avoided if at all possible, because otherwise the potential and the positive characteristics of the powder will not only remain unused, but may even be destroyed!

Overcharging the powder produces surface defects, which can be seen in particular with high-charge powders (charge type A). The reasons for this are excessively high electrical field line concentrations or excessively high free ion stream per unit of time and area. In easy-to-re

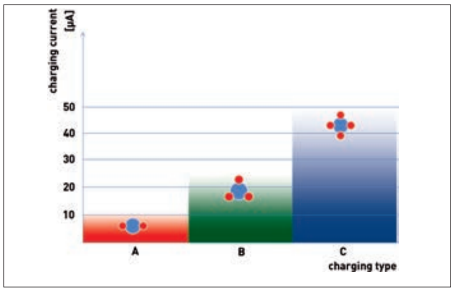

Figure 7: Each powder's charging current

ach areas, back-ionization takes place, whereas in more shielded areas an insufficient coating thickness is produced. For charge type A, it must accordingly be possible to carry out very precise regulation. To cope with the characteristics of the powder, PCC mode (Precise Current Control) has been developed for the gun control units in the latest Gema OptiStar genera-tion. PCC mode regulates the charging current in the range below 10 µA with a resolution of 0.5 µA (figure 8). This directly influences the charge level of the powder.

The controlled influencing of the current values demonstrates that each powder has an optimum charge value. If this value is used, it is possible in practice to achieve the best results and the "the more charge the better" philosophy becomes outdated. To improve the quality of the coating, it is worth paying great attention to the charge process of the powder.

It's all about the powder cloud

The design of the spray nozzle is crucial for the formation of a homogeneous powder cloud and the atomization of the powder for charging. When describing powder clouds, the words 'soft' and 'hard' are often used. Regardless of this characteristics, the powder cloud in front of the object to be coated must be an optimum shape and at the right speed. This can be influenced depending on the coating requirements.

For proper atomization and fanning-out of the transported powder, the powder-air mixture must be at a certain speed at the spray nozzle of the powder gun. In the case of injectors, and also in the application pump, this is done with supplementary air (also called atomizing air), which is additionally added to the conveying air.

In modern injector technology, this air is supplied to the injector and transports the powder to the spray nozzle together with the conveying air. To keep the ratio of the airs constant, Gema control units use the so-called digital valve control (DVC) technology. DVC is an electronic air-flow control system, which regulates the two air flows and thus also the powder-air mixture very quickly, precisely and reproducibly by means of a stepper motor (figure 9).

With the OptiSpray application pump, atomizing air is added directly at the powder gun. This means that, irrespective of the low air flow for transporting the powder, a precisely controlled quantity of atomizing air is available for forming custom powder cloud shapes (figure 10). Both air flows are introduced into the process where they can have their full effect. This allows controlled charging and atomization and prevents a pulsing powder cloud. A pulsing powder cloud means that the powder particles are fed to the gun in bursts and the charging process is not carried out constantly, which leads to irregular coating results.

The shape of the nozzle is ideally chosen according to the part to be coated or the coating requirements (figure 11). The shape and the speed of the powder cloud are specifically influenced via the control unit in an easy way, with the help of the atomizing air flow. The air speed in front of the object should generally not be too high so that the electrostatic force of attraction can assume the task of building up coats. More atomizing air automatically means an increase in speed at the spraying nozzle and consequently less air means a lower speed. Every new part to be coated can present a challenge. Even the most experienced operator must also come close to the ideal settings, depending on the coating specifications, the shape of the parts, the design of the hangers, the air currents within the booth and the conveyor speed. In addition to his experience, the operator is helped with the latest generation of application technology, which has various options to positively influence the coating result.

In order to coat difficult areas such as recesses, in addition to adjusting the powder cloud it is also possible to work in PCC mode. In the case of recesses, the

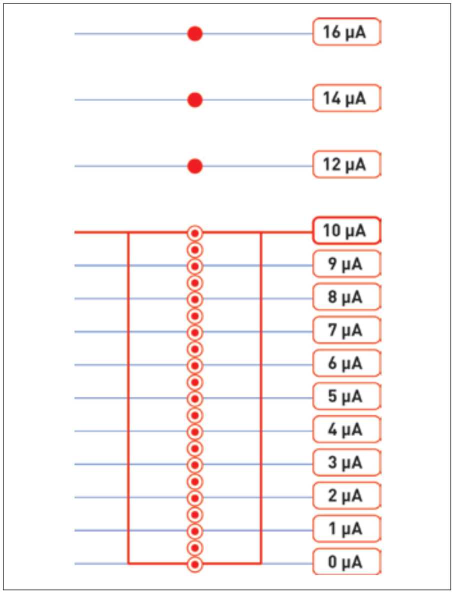

Figure 8: Extended control range of the PCC mode

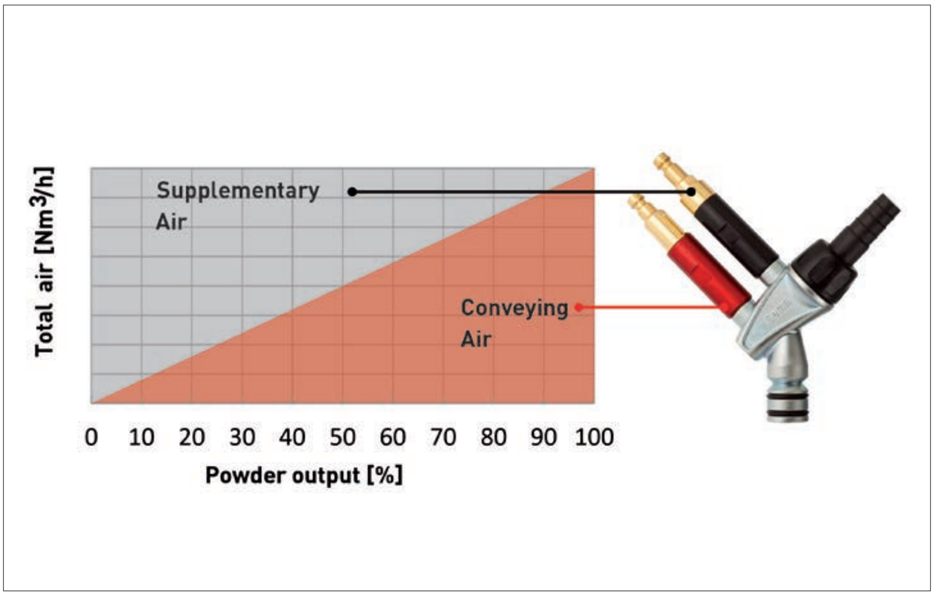

Figure 9: DVC electronic air-flow control

law of the Faraday cage must often be observed. This means that the field lines end outside the recess and are complete absent within the recess. As a result, there is no electrostatic force of attraction and powder particles only enter the recesses via the delivery air, if at all. The charging current of below 10 μA, precisely regulated with PCC mode, allows such a strong reduction of charge that the powder particles detach from the field lines and enter the recess by virtue of their own kinetic energy. This results in a better coating result and manual coating can be dispensed with in some circumstances.

PCC function for double-coat powder application

Increased anti-corrosion requirements are in practice often implemented with a double layer of powder. This means that the process of coating and curing is carried out twice in succession. A particular focus here is preventing corrosion on cut edges. Efforts are currently underway to develop a "powder on powder" application with just one curing process. Until now, it was assumed that the base coat must be applied using electrostatically charged powder and the top coat by means of tribo-charging.

The PCC function (precise current control below 10 μA) integrated in the application devices by Gema provides the opportunity to work with very low μA values. In several practical lab trials it has been demonstrated that, with the PCC function in the "powder on powder" application, both coats can be applied without any problems using electrostatic charging.

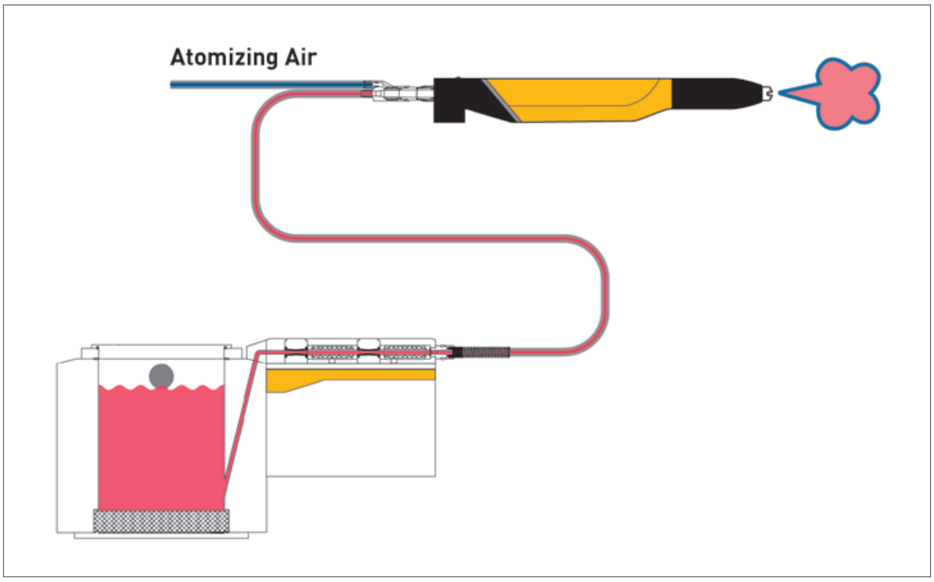

Figure 10: Controlled mixing of conveying and atomizing air shortly before application

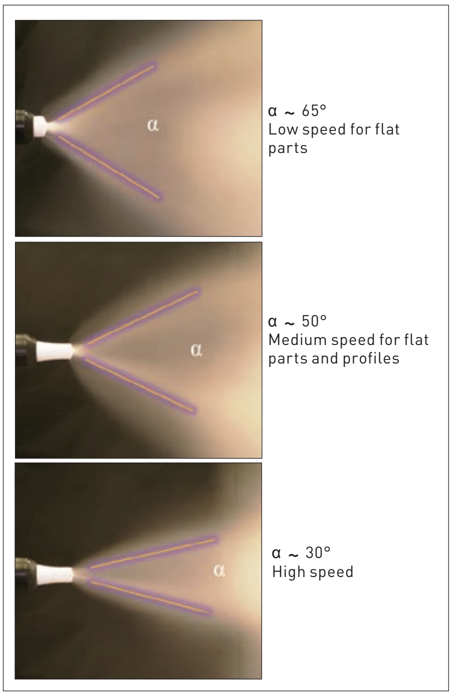

Figure 11: Flat-jet nozzles for a wide range of uses

Conclusion

Both powder delivery technologies, dense-phase pump and injectors, are based on the same operating concept and use the same control unit and gun platform. Regardless of the delivery technology, all the relevant requirements for powder charging and atomization are integrated, including the use of the precise current control in the low μA range.

The areas of application of the two delivery technologies are clearly distinct from one another, however, and are essentially determined by the field of use and the quality requirements of the user.

The robust and optimized injector technology provides the best coating results but requires ongoing process monitoring and regular maintenance. If minor differences in the coating quality are unimportant, the injector is an excellent solution.

Dense-phase technology is aimed at users who have to meet high quality demands from their customers and who themselves make high demands on their end products and place an extremely high value on process reliability. These users must be able to rely on technology, which monitors and controls the fundamental influencing factors of the coating process.

A coating system which achieves consistently reproducible results with modern technology over a relatively long period of time generates confidence in the coating process and reduces quality control costs. GEMA has implemented these requirements in the development of the new OptiSpray application pump and the latest generation of application devices. The result is a self-contained, coordinated application and powder-delivery system which generates high-quality coating results that can be reproduced at any time.

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