UV Economic Case Study —Flat Composite Substrate

By Michael Kelly and David Hagood

Sustainability is the capacity to endure. In ecology, the word describes how biological systems remain diverse and productive over time. For humans, sustainability is the potential for long-term maintenance of well-being, which has environmental, economic and social dimensions. For business, it is a major movement that will continue to gain influence in the global marketplace.

Economics of Sustainability

These efforts to "go green" are being led by environmentalists, government agencies, manufacturers, consumers and others to improve sustainability worldwide. The coatings marketplace—consisting of raw material manufacturers, equipment suppliers and formulators—continues to use UV/EB technologies to lead the sustainability effort worldwide and positively impact manufacturing, especially in Europe and the United States. This movement is called "Sustainable UV™."

The question facing manufacturing today is how to balance the three aspects of sustainability—the economic, environmental and social concerns. While all three aspects are important, the economics of sustainability ultimately drives business development.

UV/EB technology is becoming the choice technology platform that delivers all three—something that is critical for U.S. manufacturing operations today.

Although the definition can be subjective, sustainable manufacturing processes have the following characteristics:

- ✔ Improved efficiency
- ✔ Reduced waste
- ✔ Natural resource conservation
- ✔ Energy savings
- ✔ Avoiding toxic or other emissions
- ✔ Contributing to a safe and healthy working environment
- ✔ Use of renewable energy and resources

Table 1

UV/EB technology provides manufacturers with the "economics of sustainability"

Faster	Requires Less	Cleaner Technology
▸ Line speeds ▸ Cure times ▸ Coating optimization	▸ Floor space ▸ Work-in-process ▸ Energy consumption ▸ Maintenance costs ▸ Capital equipment costs ▸ Quality costs	▸ No/low volatile organic compounds (VOCs), hazardous air pollutants (HAPs) or normal vinyl pyridones (NVPs) ▸ Reduced reporting ▸ Improved health and safety

- ✔ Products made from salvaged, remanufactured or recycled material

Clearly, UV/EB technology can meet the criteria of the first six items listed above, with increasing potential for the seventh. Many efforts are underway within various companies and communities to address the last characteristic. In many instances, UV/EB topcoats are being applied on salvaged, remanufactured or recycled materials.

Faster, Smaller, Cleaner Process

UV coatings offer a process that is faster, smaller and cleaner; and delivers economic cost savings to the customer. Table 1 outlines the process results.

Faster—UV technology can lead to faster line speeds, cure time and coating optimization. The manufacturer is able to run their process at a higher line speed, which offers them more production capability without allocating additional capital. In addition, the UV process offers the manufacturer the benefit of a cure time that is less than two seconds. That offers many benefits, ranging from immediate handling to reduction in quality costs. Also, UV coatings can be 100% solids, so there is no evaporation or solvent content. This allows the manufacturer to utilize all of their coating for 100% optimization.

Smaller—From a production standpoint, UV offers the manufacturer the ability to implement a process that consumes a great deal less floor space, mainly by eliminating conventional heat ovens and conveyors. Work-in-process is virtually eliminated due to the UV process' instant cure properties. The elimination of the ovens and additional conveyors results in greatly reduced energy costs. Lower capital equipment costs are also significant due to the need for less actual equipment, typically in the range of 50 to 60 percent less. Quality costs are also minimized due to the coat-cure-and-pack philosophy of UV technology, which allows for immediate inspection after cure.

Cleaner—UV technology is sustainable—and offers significant environmental benefits, including no VOCs, HAPs or NVPs. Typically, UV also offers the manufacturer reduced reporting, and a cleaner and safer work environment.

Case Study: Flat Composite Substrate

Existing Process—Reasons for Change

The customer's existing solvent-based coating systems were in-house. When the customer had the opportunity to dramatically increase their overall business with a new business application, they were faced with the issue of dealing with a heat-sensitive substrate and requirements for fast production speed greater than 250 feet per minute. This high production speed requirement presented a unique opportunity to address other process issues, including the high energy costs of oven-based coating solutions, larger floor space requirements, environmental/workplace concerns and local regulations.

Potential Solutions—Technology Reviews

The manufacturer looked at a variety of potential solutions, including:

- Water-based coating
- Solvent-based coating
- UV-based coating

The manufacturer evaluated each coating technology based on details provided on the most recent changes and updates for each respective technology. This gave the manufacturer the data required to perform a comparison model of each technology and its pros and cons.

Water-Based Technology

Water-based coating technology would provide a better solution than their existing solvent-based coating by reducing the overall level of VOC emissions. But the physical footprint of the drying oven would be too large and consume an excessive amount of manufacturing floor space. In addition, the cool-down time required for the parts would consume too much time. Also, the water-based process equipment would have very high capital costs, as well as increased energy consumption that would be cost-prohibitive.

Solvent-Bbased Technology

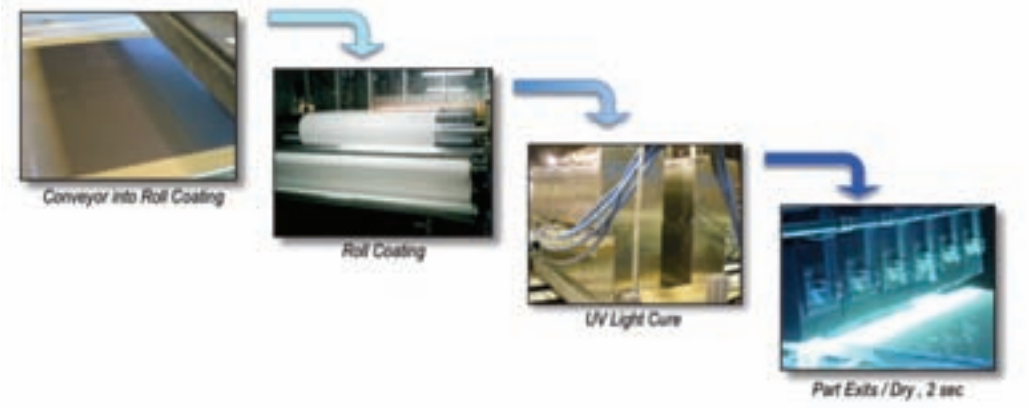
Their existing coating solution was solvent-based and has been used in production for the past seven years. Based on the experience of running the existing production and the heat limitations of the substrate, the option of expanding the solvent-based coating system was ruled out. While technically feasible, it would be cost-prohibitive, plus it would expand the use of hazardous solvent materials and VOCs.

100% Solids UV-Curable Coating Technology

UV-curable coating technology was initially investigated based on the quick drying time of the coating, which is less than two seconds. The customer quickly realized that their existing rollcoating could be utilized, thus providing a good use of existing capital. In addition, the UV-cure system could be placed immediately afterward, thereby only consuming 30 feet in

Figure 1

Overall UV process—flat composite media



length—a very small overall footprint. The energy efficiency of the UV-cure system provided significant cost savings for the customer's operations, while the immediate quality inspection of the coated parts offered significant quality cost savings. The customer was also pleased to remove all solvents and VOCs from their coating operation, which offered a healthier and safer workplace for their employees.

Faster Line Speed

UV coatings typically deliver much faster line speeds than conventional water- and solvent-based coating technology. In this case, the customer was able to increase production output by 16%—the limit due mainly to physical handling of the substrate material from the upstream process. The customer was able to increase production from 250 feet per minute to 290 feet per minute.

Coating Cost Analysis

Compared to the existing solvent-based coating, the cost per part is $1.46 compared to $1.55; saving $0.09 per part with the UV coatings technology.

Return on Investment (ROI)

The investment required for installing the UV line was approximately $637,000. As you can view in Table 4, the return on investment for switching to a 100% solids UV line estimated at around seven months using the coating-per-piece price as the only factor in the ROI equation.

Other Factors Not Taken into Account in Payback

Some of the other factors to consider in the full ROI calculations:

- Overall energy savings

Table 2

Faster line speed

Description	Solvent-Based	100% Solids UV Coating	Comments
Line speed (ft./min.)	250	290	UV can run faster with much smaller physical footprint
Minutes per day worked	960	960	16 hours/day x 60 minutes/hour
Production/week	240,000	278,400	Parts on 6" centers = [(2 parts/ft. x line speed)*minutes of production]*days per week
Annual Production	**12,480,000**	**14,476,800**	**UV produces 16% more product based on increased line speed**

Table 3

Coating cost analysis

Description	Solvent-Based	100% Solids UV Coating
Coating cost/gallon	$28	$72
Solids by volume	33%	100%
Theoretical coverage square ft./gal. @ 1 mil	529	1604
Coating thickness applied	0.9 mil	1.0 mils
Actual coverage square ft./gal.	588	1,604
Transfer efficiency without reclaim	98%	98%
Actual applied square ft./gal.	576	1,571
Coating recovery collection	roll coat	roll coat
Additional square ft./gal. using recovery system	0	0
Total square ft./gal. applied	576	1,571
Parts coated per gallon (32 sq./ft./part)	18	49.1
Cost of coating per part	$1.55	$1.46

- Floor space savings
- Quality cost reduction
- Elimination of hazardous waste on-site
- No VOCs, HAPs or NVPs
- Increased production rate
- And other savings

Conclusion

The customer decided to move forward with the project based on the ability to increase overall production, while saving on the per piece part. The customer also spent considerable time calculating the additional cost savings, but would not share this data as it was deemed confidential.

Overall Conclusion

Organizations with an eye on sustainability are realizing that embracing green practices can be a direct route to a successful, profitable business that adds value to manufacturers, their customers, shareholders and the planet.

While sustainability alone is important, the "economics of sustainability" is critical to manufacturing today and tomorrow. Manufacturers must continue to implement sustainable technologies, but the success of this sustainable technology depends on the economic/financial return to their operations. UV technology offers a definitive sustainable road map and delivers true economic savings.

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Table 4

Return on investment analysis/summary

Description	Solvent-Based	100% Solids UV Coating	Comments
Coating cost/part	$1.55	$1.46	
Annual volume	12,480,000	12,480,000 – 14,476,800	16% increase with UV
Annual cost total	$19,344,000	$18,220,800	Even if UV volume is doubled, annual cost is only $630,670
Annual savings	$0	$1,123,200	
System investment for UV System—$637,000 **Return on investment at same production rate using coating cost: ~ 7 Months**			