



Application and Growth of UV Curing Technology in China

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This article highlights the markets for radiation-curable products in China as the Chinese market has been growing rapidly in recent years. It summarizes the input of around 122 leading companies, including 68 that produce raw materials, 105 that manufacture UV products, and 14 that supply UV lamps and equipment (some of them supply multiple products). In 2005, the growth rates of raw materials and UV-curable products were 37.9% and 11.7%, respectively. The production values of raw materials and radiation-curable products increased with growth rates of 44.5% and 15.3%, respectively. However, the production value of UV lamps/equipment decreased by 25.6%, because of the high growth rate of 42.0% in 2004. The market trends and growth rate of each major segment for UV products in 2005 are also reviewed.

INTRODUCTION

Continuously increasing environmental concerns and ongoing legislation to cut the emissions of volatile organic compounds (VOCs) have been the major driving forces behind the fast development of radiation curing technology over the last few decades. Radiation curing, including ultraviolet (UV) and electron beam (EB) curing technology, is now being increasingly used in various sectors of applications because it is a type of "clean and green technology." Currently, this technology is commonly utilized to perform the ultra-fast drying of protective coatings, varnishes, printing inks, and adhesives, and to produce the high definition images required in the fabrications of microcircuits and printing plates. In addition to its great speed and spatial saving, radiation curing presents many other advantages compared with other traditional curing methods; in particular, ambient temperature operation, solvent-free formulations, low energy consumption, and the production of polymer materials with tailor made properties.

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The markets for radiation-curable products have been greatly expanded in China. However, the strong growth in radiation curing in China currently is still predominantly in UV-curing technology. Limited by the price of accelerator, the development of EB application is still slow. Only a few EB lines for ink and adhesive applications have been established in recent years.

Table 1—Industrial Applications for UV Products

<i>Furniture Construction</i>	<i>Electronics and Telecomm</i>	<i>Printing and Packaging</i>	<i>Automotive</i>	<i>Consumer Goods</i>
Wood	PCB assembly	Inks	Head lamps	Plastic casings (TV, mobile phone)
PVC flooring	PCB protective coatings	OPV	Clearcoats (interior and exterior)	
Foils	Optics fibers	Release coatings	Printed dashboard components	Skis and equipment
MDF	CD clearcoats			Spectacle lenses
				Mirror coatings

GENERAL TRENDS OF UV-CURING MARKETS

The growth in the radiation curing markets is not a simple issue. There are trends away from some chemical types of resins, multifunctional monomers, and photoinitiators, and trends towards others. Likewise, some end-uses are currently more successful than others. Subsequent growth in these applications stems in some cases from increasing penetration of UV technology, and, in others, from an overall market need for coating products. For the purpose of market understanding, the industry can be segmented by application areas. Currently, the largest application area for UV coatings in terms of volume is furniture and construction, where these coatings products are used mainly on wooden furniture and also on various flooring surfaces. This application area is closely followed by printing and packaging industries, which includes inks and clear overprint varnishes (OPV). Table 1 lists the typical applications for UV coatings within each of the major industries.

MARKET GROWTH OF RADIATION-CURING PRODUCTS

In the past decade, the market growth of radiation curing has been rapid and a wide variety of factors will further promote the growth in China, including increasing environmental protec-

tion consciousness, VOC legislation, and greater liberalization of the media, distribution, and competition among industries.

It is natural for the high market growth to meet the demands of the fast national economy development, and for the production, along with consumption, to start from a lower volume basis. However, in the last three years the upgrading of domestic output and the

Figure 1—Market share of raw materials, UV products, and UV lines from 2001–2005.

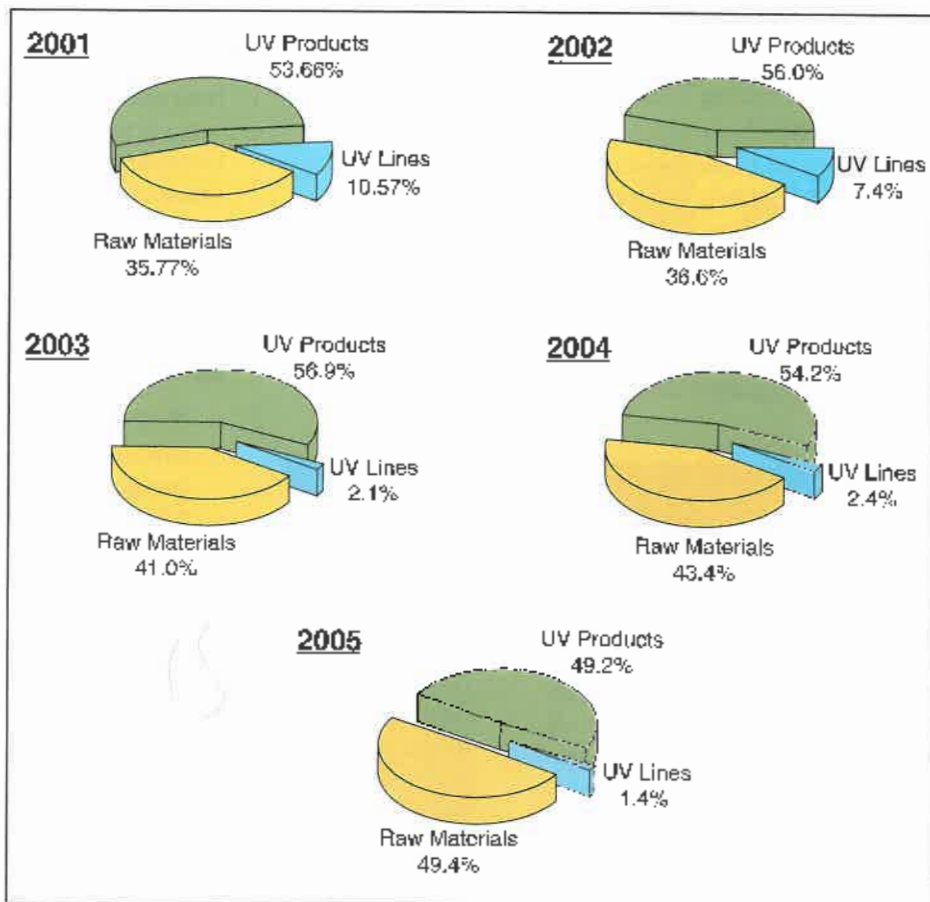


Table 2—Output and Production Values for UV Curing in 2004 and 2005

Products	Corporations		Output (ton/year)			Production Value (million U.S. \$/yr)			
	2004	2005		2004	2005	Growth (%)	2004	2005	Growth (%)
Raw material	14	16	Monomers	24,350 ^b	36,528 ^b	50.0	85.8	118.8	38.4
	25	29	Oligomers	14,120	19,825	40.4	28.4	51.6	81.6
	18	23	Photoinitiators	14,723	16,995	15.4	102.8	143.2	39.3
UV products	44	51	Coatings	23,300	25,024	7.4	110.4	114.3	3.5
	35	36	Inks	9,056.5	11,039	21.9	74.1	103.9	40.2
	10	14	Adhesives	242	383	50.0	7.9	4.4	49.7
	4	4	Print plates	2,436 × 10 ³ m ²	2,503 × 10 ⁴ m ²	2.8	83.2	89.5	7.6
UV lines	5	5	Lamps	29.3 × 10 ⁴ sets	26.1 × 10 ⁴ sets	-11.0	3.6	2.7	-24.6
	12	9	Equipment	1,410 sets	1,510 sets	6.3	8.5	6.3	-26.0
Total	109 ^c	122 ^c	Raw materials	53,193	73,348	37.9	217.0	313.6	44.5
			UV products	37,598.5	36,426	11.7	270.6	312.1	15.3
			UV lines	—	—	—	12.0	9.0	-25.6
			Total	85,791.5 ^b	109,774 ^b	28.0	499.7 ^c	635.9 ^c	27.3

(a) Some corporations supply multiple products.

(b) Including the output of a Taiwan factory.

(c) Including the production value of UV lines.

values of radiation curing products have become even more significant in comparison with the past.

Moreover, radiation-curing applications have also expanded to some new fields. There has been the appearance of domestic companies dealing with radiation curing. Based on the investigations of leading companies, the market shares of raw materials, UV products and UV lines during 2001–2005 are shown and compared in Figure 1.

Coatings and inks remain the largest application areas for UV-curable materials in China. Although a portion of radiation curable products are still imported, the products produced by Chinese manufacturers have expanded rapidly in the past few years. The total outputs of radiation-curable coatings and inks, respectively, were 25,024 tons and 11,039 tons in 2005, while in 2004 the figures were 23,300 tons and 9,056 tons, re-

spectively. Therefore, the growth in production value was 3.5% for coatings and 40.2% for inks in 2005, compared with 34.5% and 34.3% in 2004, respectively.

RAW MATERIALS

Over the recent years, the world chemical industry has been hugely impacted by a combination of factors including core material and energy price surges and increasing environmental regulations. The growth rate of raw materials has been slowed due to geopolitical un-

Table 3—Output of UV Coatings (Ton) in 2004 and 2005

UV Products	2004	2005
Wood/bamboo	14,490	13,543
Paper	4,316	5,812
PVC	1,325	1,757
Plastic	1,919	2,347
Automotive	800	666
Electronic appliances	190	322
Metal	33	71
Others	227	511
Total	23,300	25,024

Table 4—Output of UV Inks (Ton) in 2004 and 2005

UV Inks	2004	2005
Offset	1,459	1,960
Gravure	183	312
Surface printing	12	27
Flexographic	155	202
Screen	1,832	2,267
Metal	563	785
Anticorrosive	205	328
Solid mask	1,750	1,851
Lithopress	287	245
Photoinageable anticorrosive	925	1,030
Photoinageable solid mask	1,184	1,355
Optical disk	501	480
Optical fiber	0.5	2
Total	9,056.5	11,039

certainty and rocketing oil prices. The production value of monomers increased from 2004 to 2005 with a growth of 38.4%, which is listed in Table 2. The output of that increased from 24,350 tons in 2004 to 36,528, in 2005, with a growth of 50.0%. The production of second-generation alkoxy acrylates had a considerable growth. The outputs of EO-TMPA, PO-TMPA, and PO-NPCDA reached 1,595 tons, 335 tons, and 350 tons in 2005, respectively. The volume of total exports of raw materials was 19,095 tons, earning \$134.9 million U.S. dollars.

Oligomers are also important products for UV curing. Although most of them were formerly imported, the production of oligomers in China has increased rapidly in recent years. In 2005, the output of oligomers was 19,825 tons with a growth of 40.4% compared with 2004, which was 14,120 tons. The production value reached \$51.64 million U.S. dollars with a remarkable growth of 81.6%. Now, not only the common oligomers such as epoxy acrylates, aromatic urethane acrylates, and aliphatic urethane acrylates, but also polyester acrylates, amide acrylates, and alkaline-developable acrylates are being manufactured in large scale by Chinese companies. The variety has become more abundant and some products have begun to be exported to foreign countries.

Photoinitiator is another key product for UV curing with a notable growth rate in recent years in China's market. The domestic routine photoinitiators not only meet the needs of the domestic markets but are also exported to foreign markets including the United States, Europe, and other regions. The output of photoinitiators in China increased from 14,723 tons in 2004 to 16,995 tons in 2005 with a growth of 15.4%. Moreover, the output of benzophenone and Irgacure 207, 184, and 1173 reached 2,705 tons, 1,665 tons, 3,960 tons and 4,200 tons, respectively, in 2005. Cationic photoinitiators and visible photoinitiators were also manufactured in a certain scale. Moreover, the production value increased from \$102.80 million U.S. dollars in 2004 to \$143.18 million U.S. dollars in 2005 with a fast growth of 39.3%. The products for exportation increased from 11,299 tons in 2004 to 13,095 tons in 2005, earning \$112.4 million U.S. dollars with a growth of 40.5%. Figure 2 shows the market shares of different raw materials used in UV-curing industries.

UV PRODUCTS

There are a very large number of end uses for radiation-curable industrial products in China. The data listed in Tables 2–4 attempt to outline and evaluate the status of output, growth, and production values of this huge diverse market. The major markets of UV-curable coatings are wood/bamboo coatings, flooring coatings,

Figure 2—Market share of different raw materials in 2005.

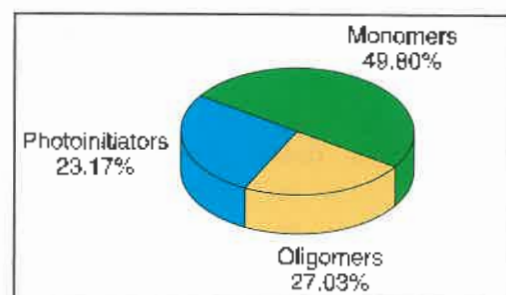


Figure 3—Market share of different UV products in 2005.

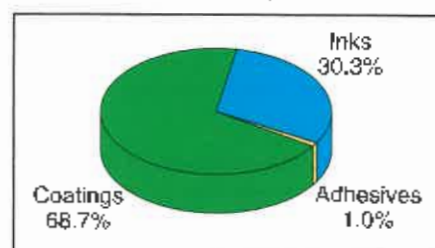


Figure 4—Output of raw materials in China from 2003–2005 (ton).

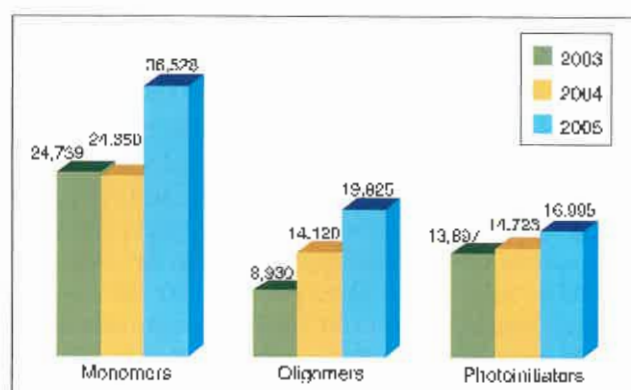


Figure 5—Production value of raw materials in China from 2003–2005 (million U.S. dollars).

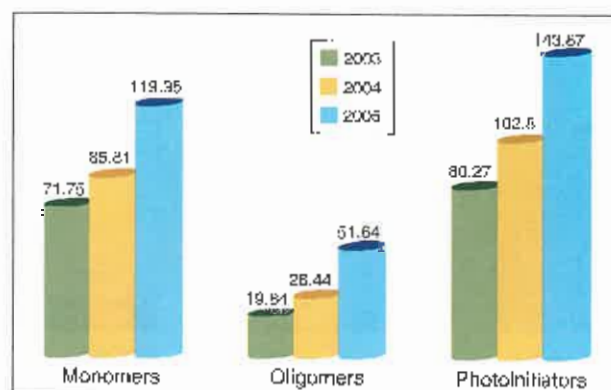


Table 5—Classification of Corporations by the Output and Production Value in 2005 Statistics

Products	Corporations	ISO Certified	Patents	Output (thousand ton/yr)					Production Value (million U.S./yr)				
				<0.5	0.5–1.0	1.0–2.0	2.0–5.0	>5.0	<1.25	1.25–6.25	6.25–12.5	12.5–25	>25
Raw materials	35	18	20	12	7	7	5	4	4	19	5	3	4
UV products	80	44	45	57	9	6	5		39	32	5	2	2
Equipment	7	2	10						4	3	—	—	
Total	122	64	75	69	16	13	10	4	47	54	10	5	6

and PVC coatings. Overprint varnishes for paper is another important market. Table 3 shows that there are still numerous areas where radiation-curable systems have barely penetrated, such as automotive coatings, anticorrosive coatings, metal coatings, and electronic appliance coatings.

The output of UV coatings was 25,024 tons in 2005, with a growth rate of 7.4%. The production values increased from \$110.4 million U.S. dollars in 2004 to \$114.8 million U.S. dollars with a growth of 3.5% in 2005. The industrial wood/bamboo coatings, with output of 13,543 tons, still represent the largest share of end uses. Overprint varnishes for paper, plastic coatings, and PVC coatings reached 5,812 tons, 2,342 tons, and 1,757 tons, respectively, last year. High grade coatings for mobile phones and optical disks seem to have injected a high level of stimulation into the market.

China is the sixth largest manufacturer of inks and accounts for 6% of the production capacity in the world. The fastest growing areas for inks in China are jet inks as well as the whole gamut of offset printing from simple news inks to high gloss inks or coldest web offset inks. The total output of 36 UV ink manufacturers was 11,039 tons in 2005 with a growth of 21.9%, compared with 9,056 tons supplied by 35 manufacturers in 2004. The production value increased to \$103.9 million U.S. dollars with a remarkable growth

of 40.2% in 2005, as listed in Table 2. The output of offset, gravure, flexographic, screen inks, and so on are listed in Table 4. Exciting news also comes from coloring inks for optical fibers as the products fill the Chinese need in markets.

The Chinese government is supportive of developing top grade and fine package printing products, increasing the additional value of products, and meeting the needs of some domestic markets and export markets. Therefore, Chinese officials emphasize that the printing industry must consolidate and develop its existing offset printing ability, increase gravure printing, screen printing, ink jet printing, and curve surface printing, develop flexo printing, and improve post-press integration and technology.

The output for radiation-curable adhesives was 363 tons in 2005 by 14 corporations, compared with 242 tons by 10 corporations in 2004. The production value increased to \$4.38 million U.S. dollars with a growth of 1.5 times that of 2004. Besides the adhesives used in medicine, glass, craftwork, packing, and fishing equipment, those in LCD, DVD, instrument, and optics applications are also being produced domestically. These

Figure 6—Output of UV products from 2003–2005 in China (ton).

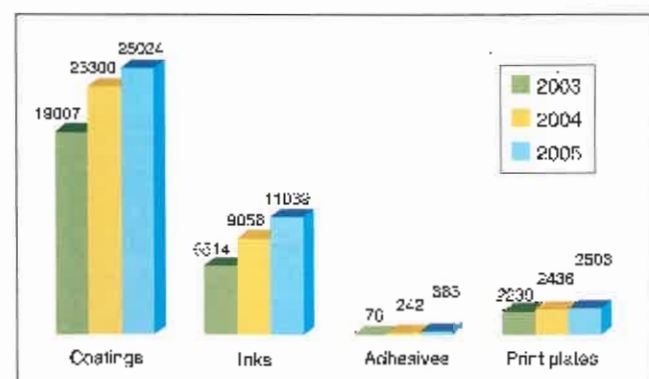


Figure 7—Production value of UV products of China from 2003–2005 (million U.S. dollars).

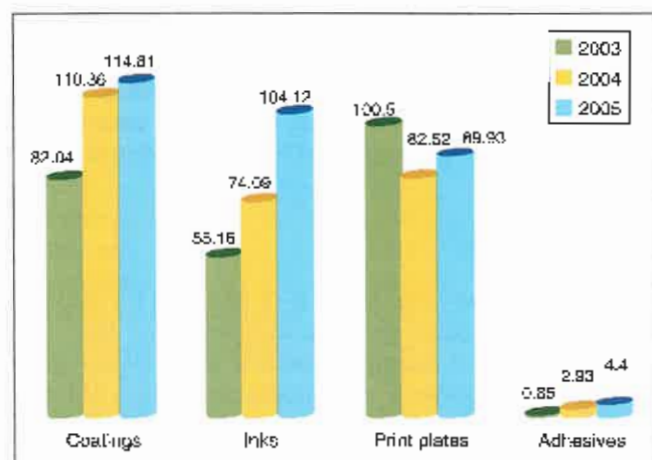
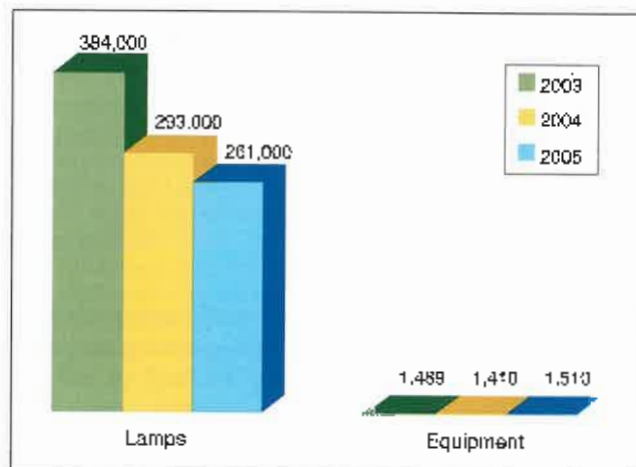


Figure 8—Output of UV lines from 2003–2005 in China.



represent a positive start as an alternative to imports. The development of radiation-curable adhesives is quite recent in comparison with industrial coatings and graphic arts. In addition to the environmental drive, other factors such as unique cure properties and the "mushroom" development of the automotive and DVD industry are strongly influencing the growth rate of radiation curable adhesives.

EQUIPMENT

The production of equipment related to UV curing showed a slowdown in its growth in 2005. About 261,000 UV lamps were manufactured in 2005, a decrease of 32,000 compared to 2004. However, 1,510 pieces of UV-curing equipment were produced, showing an increase of 6.3% over the last year. The total production value of UV-curing equipment was \$8.96 million U.S. dollars with a negative growth rate of -25.6%, including the production of 34 UV coating lines. The export value of UV coating lines was \$0.75 million U.S. dollars in 2005.

CORPORATIONS INVOLVED IN RADIATION-CURING TECHNOLOGIES

There are definite opportunities for many companies to flourish in radiation-curing (radcure) markets. Although double-digit growth rates are no longer the norm, the radcure market continues to experience positive growth rates. According to a recent survey by Radlech China, there are mainly 122 corporations involved in the radcure market. ISO 9001 or ISO 9002 has certified 64 corporations among all of those currently operating. The output of more than 14 corporations has exceeded 2,000 tons and the biggest one ex-

Figure 9—Production value of UV lines of China from 2003–2005 (million U.S. dollars).

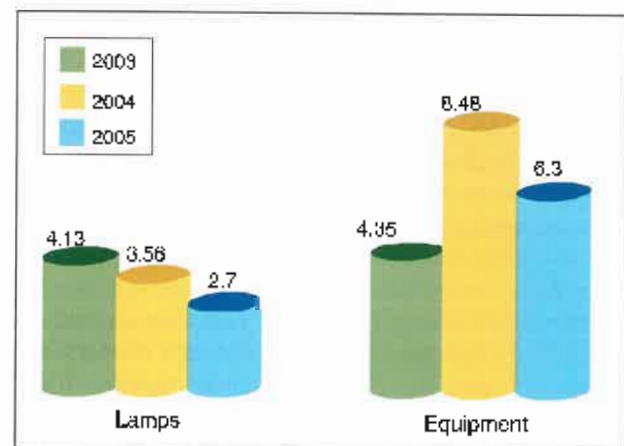
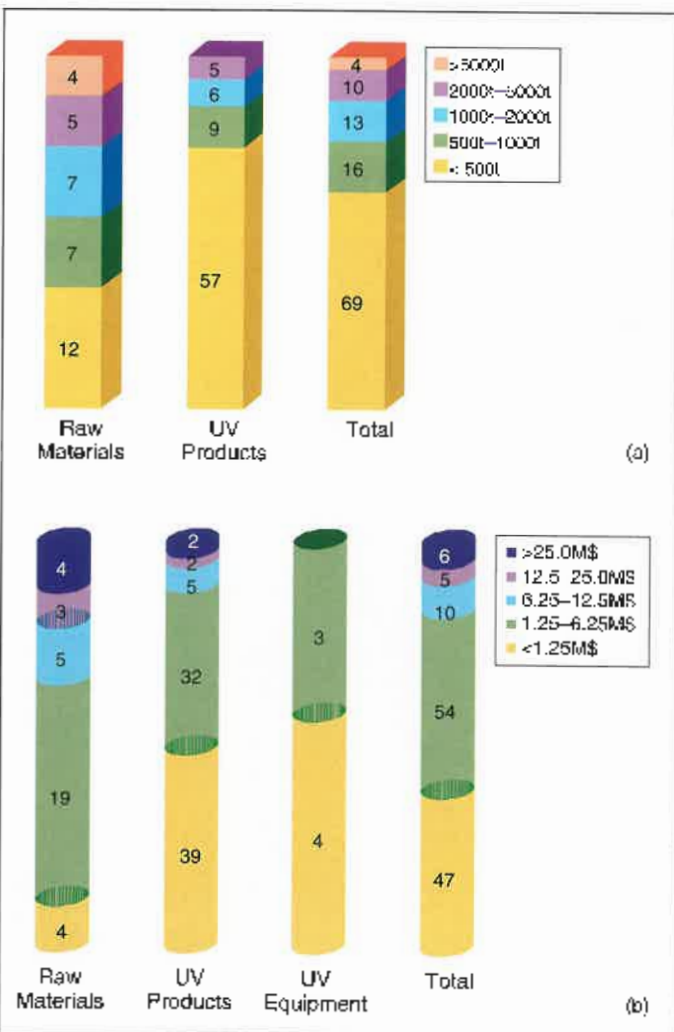


Figure 10—Development of corporations involved in UV curing in China in 2005. (a) Output scale of different manufacturers (ton/year); (b) Production value of Chinese corporations in 2005 (million U.S. dollars).



ceeded 10,000 tons. There are 11 corporations whose production value has exceeded \$12.5 million U.S. dollars. The details are listed in *Table 5*.

The Chinese market has established a fair environment to enable enterprises of all kinds of ownership—including private companies, joint ventures, and state-owned companies—dealing with radiation curing to compete on an equal footing. In addition, some foreign companies, such as DSM, Fusion, Sartomer, Ciba, ChemFirst, BYK, BASF, Tego, and Bayer, have established offices or conduct business in China, contributing to the development of Chinese radiation-curing markets. The implementation of some new economic strategies will also provide new business opportunities for the radiation-curing technology.

MARKET POTENTIALS AND OPPORTUNITIES

China boasts the largest population in the world and has vast territories. This factor alone provides increased market potential and market opportunities for

the development of radiation-curing technology. China is integrating into the global economy rapidly and actively. China's international economic relationships are becoming more diversified. The continuing development of China's economy is accompanied with urgent requirements for high and new technologies, including radiation-curing technology.

CONCLUSIONS

This brief overview of the Chinese UV-curing market in 2005 has shown that there are still great opportunities for developing radiation curing. The high growth rate will continue through further evolution in well-established areas (wood coatings, screen and offset inks, etc.), addressing technological shortcomings by developing new technologies and new raw materials (UV-curable waterborne products, UV-curable powder products), and by entering new application fields (composites and gel coats, automotive OEM, refinish coatings, etc.). □