

Applications and Growth of UV Curing Technology in China

Wenfang Shi¹, Youkai Jin², Yangzhi Jin²

¹Department of Polymer Science and Engineering, University of Science and Technology of China, Hefei, Anhui 230026, P. R. China

²RadTech China, Beijing, 100084, China

¹Fax: +86-551-3606630 E-mail: wfshi@ustc.edu.cn

Abstract

The objective of this paper is to highlight the markets for radiation curable products in China as the Chinese market has been growing rapidly in recent years. This report summarizes the input of around 109 leading companies, including 37 that produce raw materials, 75 that manufacture UV products and 12 that supply UV lamps and equipment (some of them supply multiple products). The growth rates of raw materials and UV curable products were 11.8 % and 27.4 %, respectively, with the total growth rate of 17.3 % in 2004. The production value of raw materials, radiation curable products and UV lamps and equipment in China increased with growth rates of 26.3 %, 13.4 % and 42 % respectively, and the total growth rate of 19.3 % in 2004. Market trends, growth rate of each major segment and technological developments are reviewed. The market information for 2005 will be presented at the Conference due to the collection problem.

Introduction

Increasing environmental concerns and ongoing legislation to cut the emissions of volatile organic compounds (VOCs) have been the major driving force behind the development of radiation curing coatings over the past 30 years. 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 clean and green technology that increases the productivity as compared with other traditional methods of curing. This technology is now 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 manufacture of microcircuits and printing plates. Besides its great speed and spatial resolution, radiation curing presents a number of other advantages, in particular ambient temperature operation, solvent free formulations, low energy consumption, and the production of polymer materials with tailor-made properties.

Despite some contradictions and problems, Chinese economy has been keeping a momentum of rapid and sustainable development in recent years. And the markets for radiation curing have been greatly expanded. The strong growth in radiation curing currently is still predominant in UV curing technology in China. Limited by accelerators, the development of EB application is still slow. However, as the price of low energy accelerator further decreases, this technology is going to be very promising in the future markets.

As a developing country, China still has a small market of radiation curable products compared with North America, Europe and Japan. However, profound changes have taken place in China's market as the reform deepens and China opens wider to the outside world. The introduction of advanced radiation curing technology from abroad is promoting the market growth of domestic radiation curing industry through the developments of telecommunication, fiber optics, mobile phones, computers, graphic arts, packaging, household electronic appliance, architectural materials and so on.

The nationwide association for Chinese radiation curing community-RadTech China founded in 1993 is playing a key role in the information exchange and business among its members and Chinese experts, and their counterparts in other parts of the world. It has been making great efforts to develop and raise the level of RadTech in china, to organize training programs and domestic conference each year. The increasing use of curable materials for coatings, inks, adhesives and printing plate provides an incentive for the developments of new varieties of oligomers, multifunctional monomers and photoinitiators. Some remarkable progress has been achieved in the research on photopolymer related with the areas of Radtech in China.

While the economies in most of the rest of the world struggled, China's gross domestic product (GDP) totaled 1.70 trillion US dollars in 2004, a jump of 9.5 percent year on year. Definitely, the ountry with the most growth last year and also forecasted for the next five to eight years is China. This article provides a short overview of around 109 leading companies, including 37 companies producing raw materials, 75 companies manufacturing UV products and 12 supplying UV lamps and equipment (some of them supply multiple products). Moreover, the trends and applications of UV products in industry and outlook of Chinese market trends and technological developments collected by RadTech China for year the 2004 are reviewed.

General trends of UV-curing markets

Growth in the radiation-curing market is not a simple issue. There are trends away from some chemical types of resins, photoinitiators and additives, and towards others. Likewise, some end-use applications 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 a buoyant overall markets

Table 1. Industrial applications for UV coatings.

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

for coated 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 volumes is furniture and construction, where these products are used mainly on wooden furniture, and also on various resilient flooring surfaces. This is closely followed by printing and packaging industries, including inks, and clear overprint varnishes (OPV). Table 1 lists the typical applications for UV coatings in each case of the major industries.

Market growth of radiation curing products

In the past 10 years, the market growth of radiation curing has been rapid and a wide variety of influences will further drive the growth in China, including increasing environmental protection consciousness, VOC legislation, greater liberalization of the media, distribution and competition among the industries.

It is natural for the high market growth to meet the demands and requirements of the fast national economy development and for the production, along with consumption, to start from a lower volume basis. However, in the latest three years the upgrading of domestic varieties output, the quality and values of radiation-curing products have become even more significant in comparison with the past.

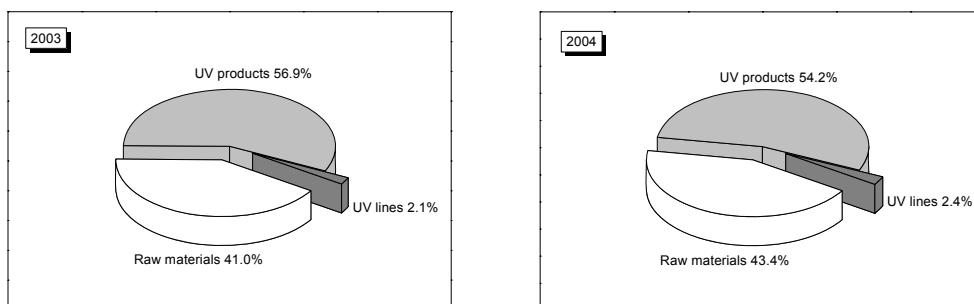


Figure 1. Market shares of different corporations working in UV curing in 2003

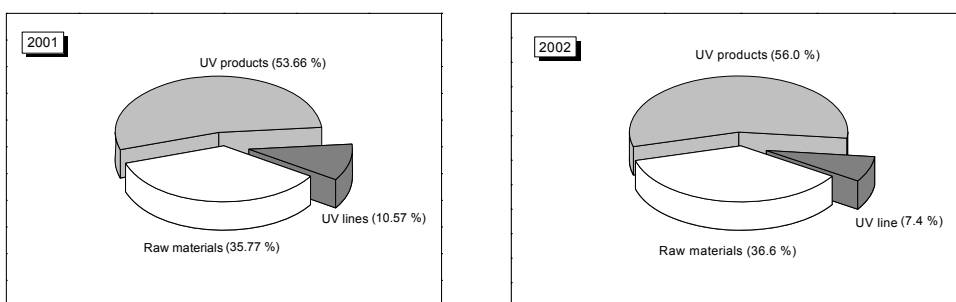


Figure 2. Market shares of different corporations working in UV curing in 2001

Moreover, their applications have also expanded to some new fields. During this period there has been the increasing number of domestic companies dealing with radiation curing. According to the investigations of 109 leading companies mentioned earlier, the developing positions of different

Table 2. Output and production values for UV curing in 2003 and 2004.

Products	Corporations			Output (tons per year)			Production value (million US dollars)		
	2003	2004		2003	2004	Growth (%)	2003	2004	Growth (%)
Raw materials	13	14	Monomers	24,739 ^b	24,350	-1.6	71.75	85.81	19.6
	18	25	Oligomers	8,930	14,120	58.1	19.84	28.44	43.3
	18	18	Photoinitiators	13,897	14,723	5.9	80.27	102.80	28.1
UV products	39	44	Coatings	19,007	23,300	22.6	82.04	110.36	34.5
	32	35	Inks	6,514	9,056	39.0	55.16	74.09	34.3
	3	4	Print plates	2,239×10 ⁴ (m ²)	2,436×10 ⁴ (m ²)	8.8	100.50	82.52	-17.2
	9	10	Adhesives	76	242	218.4	0.85	2.93	243.8
UV Lines	5	5	Lamps	38.4×10 ⁴	29.3×10 ⁴	-23.7	4.13	3.56	-13.6
	12	10	Equipment	1,489	1,410	-5.3	4.35	8.48	94.7
Total	95 ^a	109 ^a	Raw materials	47,566	53,193	11.8	171.85	217.04	26.3
			UV products	25,597	32,598	27.4	238.55	270.58	13.4
			UV lines	-	-	-	8.48	12.04	42.0
			total	73,163	85,791	-	418.88	499.66	19.3

a) Some Corporations supply multiple products.

b) Including the output of a Taiwan factory.

c) Including the production value of 43 UV coating lines.

Table 5. Classification of corporations by the output and production value in 2004 statistics.

Products	Corporations	ISO certified	Patents	Output (thousand tons/year)					Production value (million US dollars/year)				
				<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	31	18	9	12	6	7	4	2	4	15	7	3	2
UV products	71	39	30	48	13	4	4		34	29	5	2	1
Equipment	7	2	2						3	4			
Total	59	59	41	60	19	11	8	2	41	48	12	5	3

companies with respect to their products in 2003 and 2004 are shown in Fig. 1, compared with that in 2001 and 2002, as shown in Fig 2.

Coatings and inks remain the largest application areas for UV curable materials in China. In the past years although a part of radiation curable products were imported, the products produced by Chinese manufacturers expand rapidly. The total outputs of radiation curable coatings and inks were 23,300 tons and 9,056 tons, respectively, in 2004, while that in 2003 were 19,007 tons and 6,514 tons, respectively. As a result, the growth in production value was 34.5 % for coatings and 34.3 % for inks.

Raw materials

Over the passing 2003-04, the world chemical industry in recovery was once again hugely impacted by a combination of factors including core material and energy price surge and some non-market factors. The growth rate of raw materials slackened its pace due to geopolitical uncertainty, rocketing oil prices. The production value of monomers has increased from 2003 to 2004 with a growth of 19.6 %, which is listed in Table 2. However, the output decreased from 24,739 tons to 24,350 tons with a negative growth of 1.6 %. Some human error in 2003 statistics was found to cause the decrease. Deducting the output of a Taiwan factory from 2003 statistics which was not included in 2004's data, the actual output may have a slightly increase in 2004. The production of the second-generation alkoxy acrylates has a considerable growth. The output of EO-TMPTA and PO-NPGDA reached 600 tons and 465 tons, respectively. The volume of total exports of raw materials was 6162 tons, earning 23.05 million US dollars.

Oligomers are another important product for UV curing. Although most of them were imported formerly, the production of oligomers in China increased rapidly in recent years. In 2004, the output of oligomers was 14,120 tons with a growth of 58.1 % compared with 2003, which was 8,930 tons. The production value has increased to 28.44 million US dollars with a growth of 43.3 %. Now, not only the common kinds of oligomers such as epoxy acrylates, aromatic urethane acrylates, aliphatic urethane acrylates, but also some polyester acrylates, amide acrylates, alkaline-developable acrylates were manufactured in large scale by Chinese companies. The variety became more abundant and the products started to export to foreign countries.

Photoinitiator is a key product for UV curing at the fastest growth rate in recent three years in China's market. The domestic routine photoinitiators not only meet the need of the market but also export to foreign markets including United States, Europe and other regions. The output of photoinitiators in China increased from 13,897 tons in 2003 to 14,723 tons in 2004 with a growth of 5.9%. Among them, the output of benzophenone and 1173 exceeded 3000 tons. Cationic photoinitiators and visible photoinitiators were also manufactured in certain scale. Moreover, the production value increased from 80.27 millions US dollars in 2003 to 102.80 millions US dollars in 2004 with a growth of 28.1 %. The products for exportation increased from 7,450 tons to 11,299 tons, earning 79.98 millions US dollars as foreign exchange with a growth of 48.8 %. Fig. 3 shows the market shares of different raw materials used in UV curing industries.

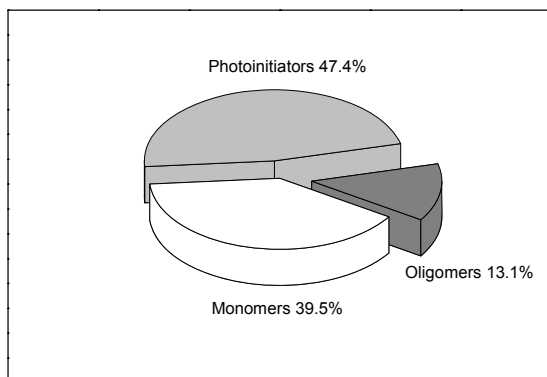


Figure 3. Market shares of different raw materials.

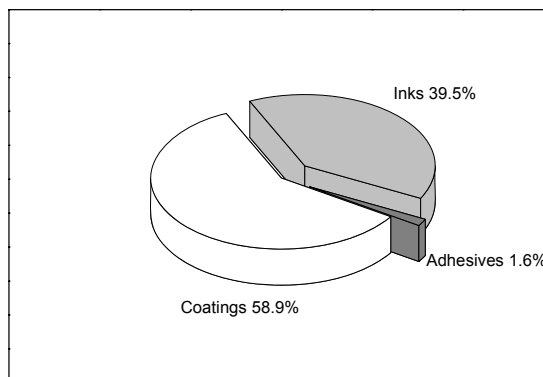


Figure 4. Market shares of different UV products.

UV products

There are a very large number of end-uses for radiation curable industrial products in China. The data listed in Table 2-4 are attempts to segment and evaluate the status of output, growth and production values of this diverse market. The major markets of UV curable coatings are wood/bamboo, flooring coatings and PVC coatings. Overprint for paper is another important market. Table 3 presents that there are still numerous areas where radiation curable systems have barely penetrated, such as automotive coatings, anti corrosive coatings, metal coatings and electronic appliances.

The output of UV coatings was 23,300 tons in 2004, with a growth rate of 22.6 %. The production values increased from 82.04 million US dollars in 2003 to 110.36 million US dollars in 2004 with a

growth of 34.5 %. Industrial wood/bamboo coatings still represent the largest share of end-uses. Other segments like plastic coatings and high-grade coatings for mobile phone and optical disk seem to inject a high level of stimulation into the market.

China is the sixth largest manufacturer of inks and takes 6 % capacity of production in the world. It is observed that the fastest growing areas in China are jet inks and the whole gamut of offset printing from simple news inks to high gloss inks or coldest web offset inks. The total output of 35 UV ink manufacturers was 9,056 tons in 2004 with a growth of 39.0 % compared with 6,514 tons supplied by 32 manufacturers in 2003. The production value increased to 74.09 million US dollars with a growth of 34.3 % as listed in Table 2. The output of offset, gravure, flexographic, screen and so on are listed in

Table 3. Output of UV coatings (tons) in 2003 and 2004.

UV products	2003	2004
Wood/bamboo	10,868	14,490
Paper	3,143	4,316
PVC	1,470	1,325
Plastic	2,218	1,919
Automotive	760	800
Electronic appliances	276	190
Metal	222	33
Others	50	227
Total	19,007	23,300

Table 4. Output of UV inks (tons) in 2003 and 2004.

UV inks	2003	2004
Offset	662	1,459
Gravure	80	183
Surface printing	30	12
Flexographic	20	155
Screen	1,279	1,832
Metal	1,050	563
Anticorrosive	259	205
Sold mask	1,201	1,750
Letterpress	201	287
Photoimageable anti corrosive	660	925
Photoimageable sold mask	525	1,184
Optical disk	547	501
Optical fiber	-	0.5
Total	6,514	9,056.5

Table 4. The excitement also comes from coloring inks for optical fibers and the products filled the Chinese blank.

Chinese are emphasizing developing top grade and fine package printing products, increasing the additional value of products and meeting the needs of some home markets and export. To do so, Chinese officials stress that the printing industry must consolidate and develop 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 242 tons in 2004 by 10 corporations compared with 76 tons in 2003 by 9 corporations. The production value increased to 2.93 million US dollars with a growth of 2.4 times that in 2003. Besides the adhesives used in medicine, glass, craftwork, packing, fishing equipment, those in LCD, DVD, instrument and optics also have been produced and have a nice beginning for the import replacement. 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 saw a slowdown in its growth in 2004. 293 thousands UV lamps were manufactured in 2004 with a decrease of 91 thousands compared with 2003. 1410 UV curing equipments were produced, seeing a decrease of 79 over the last year. However, the total production value was 74.09 million US dollars with a remarkable growth rate of 94.7 %, due to the enhanced production of 43 coating lines. And for the first time, one UV curing line was exported.

It is recognized that EB curing has great advantages in comparison with UV curing to formulate materials without using photoinitiators. However, the EB curing technology has not been widely accepted in China. EB accelerators are normally used in the radiation processing heat shrinkage materials and cross-linked cables and wires. Currently, there are very few EB facilities for radiation curing on an industrialized scale due to its expensive cost.

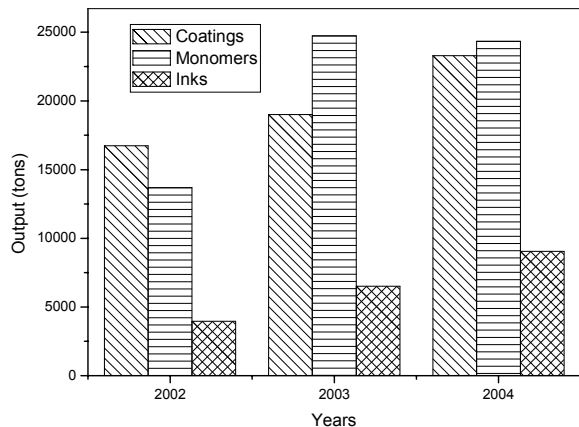


Figure 5. Major contributing outputs showing the development of UV curing in China in the past three years.

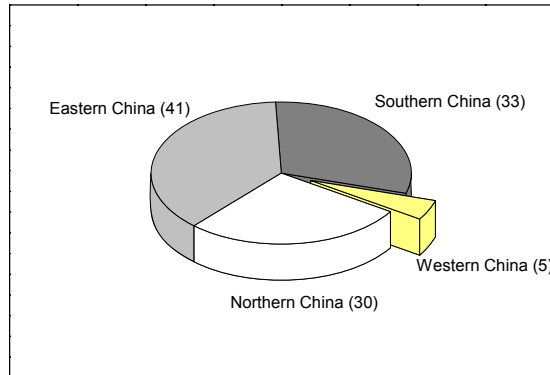


Figure 6. Amount of corporations related to radiation curing by region.

Development of corporations involved in radiation curing technologies

There are definite opportunities for many companies to flourish in radcure markets. Although double-digit growth rates are no longer the norm, the radcure market continues to seek post number growth rates. According to recent the survey by RadTech China, there are mainly 109 corporations, 71 of them supplying UV products, 17 corporations partly producing monomers, oligomers and photoinitiators, while the other 7 corporations mainly manufacturing UV curing equipment. According to detailed information of these corporations, there are total 6,648 employees working on UV curing, among them 1,225 (18.9 %) technicians. ISO 9001 or ISO 9002 has certified 59 corporations among all those currently operating. The output of more than 10 corporations exceeded 2 thousand tons and the biggest one exceeded 10 thousand tons. There are 8 corporations whose production value has exceeded 12.5 million US dollars, 2 more compared with that in 2003. The details are listed in Table 5. Figure 6 offers a classification of these corporations by region. The imbalance between different areas has been rising with the development of industrial scale. Among 109 corporations, only 5 of them located in western china, sharing a small fraction (1.5%) of the total production values. Raw materials were mainly produced in eastern china. 30 corporations in southern China represented the lion share (71.0 %) of total output of UV products while 8 of 12 equipment manufacturers operated in northern China. Chinese market has established fair environment to make enterprises of all kinds of ownership, including private companies, joint ventures and state owned companies dealing with radiation curing, compete on an equal footing. In addition, some foreign companies, such as Fusion, Sartomer, Ciba, UCB, DSM,

ChemFirst, BYK, BASF, Tego, Bayerand, and so on, have established their offices or conducted business in China, contributing to the development of Chinese radiation curing markets. The implementation of the ambitious western development campaign will also provide new business opportunities for the radiation curing technology. In fact, Chinese government is supporting the country's strategy of opening up the western region with preferential policies including an increase of funds for infrastructure construction, environmental protection and incentives for overseas investment.

Market potentials and opportunities

China is a developing country with one fifth of the world population and vast territories. This fact itself is the inclusion of the market factor with potentials and opportunities for radiation curing technology. The economic weight in the world economy of China, with its growth of over 9 per cent annually for more than two decades, has been rising. With its external sector expanding more vigorously than that of the rest of the world by a wide margin, China is integrating into the global economy rapidly and ubiquitously. China's international economic linkages become more diversified. The sustaining development of China's economy has to accompany with the urgent requirements for high and new technologies including the radiation curing technology. Moreover, Beijing has been selected as Host City of the 2008 Summer Olympic Games. This event means a number of key projects related to the 2008 Summer Olympic Games will be starting before long. The paint and coatings industry appears to be a major beneficiary, which can possibly bring a promising application field for radiation curing.

Conclusions

This short overview of Chinese market has shown that there are still many opportunities for growth in radiation curing. High growth will continue through continued 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, UV curable powder), and by entering new application fields (composite and gel coats, automotive OEM and refinish coatings etc.).