sis, and the reduction of noise to a satisfactory level. It has proven possible to register the sensors sufficiently accurately, and it is not anticipated that this factor will prove a significant barrier to any future development. Likewise, it has been found possible to achieve good color reproduction using standard color splitter prisms and infrared filters, together with a small amount of color correction. While some work remains to be done in order to optimize the color performance, it is nevertheless clear that the color analysis system is fairly straightforward, in spite of the problems with the low blue response of the CCD sensors.

The noise level remains an unsolved problem, however. While the introduction of sensors with improved blue sensitivity will help to equalize the noise levels in the red, green, and blue channels (which, in turn, will help to eliminate unwanted color casts in dark areas), the overall visibility of noise will still be worse than with a flying-spot telecine, particularly in dark areas. In order to overcome this, sensors with low levels of electrical noise are required. Such sensors have been developed for use in low-light-level camera applications, but none are yet available which are suitable for CCD telecine application.

Acknowledgment

The authors wish to thank the Director of Engineering of the BBC for permission to publish this paper.

References

1. Ian Childs and J. Richard Sanders, "An Experimental Telecine Using a Line-Array CCD Sensor," *SMPTE Journal, 87:* 209–213, Apr. 1978.
2. R. P. Marsden, "Electronic Masking for Telecine: A Review of Masking for Positive and Negative Film," BBC Research *Dept. Rept.* No. 1975/16.
3. N. Suzuki, "New 1024-Element Charge-Coupled Linear Image Sensor with High Intensity," *Electronics Letters, 13:* No. 24, 716–717, 1977.

The Use of Polyester Film Base in the Motion Picture Industry — a Market Survey

By GEORGE J. VAN SCHIL

Several important segments of the professional photographic industry are using film products on polyester base. To date, the motion picture industry has primarily used polyester base for super 8 and some 16mm applications. Polyester base offers distinct advantages over triacetate base which would make it particularly suitable for other motion picture applications. Polyester has greater tensile and tear strength, is less apt to suffer surface abrasions on the base side, and is far more dimensionally stable. Some of the concerns the industry has on polyester base are in the areas of splicing, slitting, rejuvenation, and the greater mechanical strength which causes fear of equipment damage. With the objective of measuring the awareness of polyester base and experience with polyester in the market, and also to investigate the readiness of the motion picture industry to accept a more widespread use of polyester base, Agfa-Gevaert sponsored a market survey of U.S. motion picture laboratories, distributors, and exhibitors. This paper reports in detail on the results of this survey. The consequences for the film manufacturer of a market moving towards increased use of polyester base conclude this report.

Introduction

Several important sectors of the professional photographic industry are using products on polyester base. The x-ray product lines and various graphic arts product lines are exclusively using polyester base. Microfilm is also moving rapidly towards a total use of polyester. To date, polyester base in the motion picture industry has primarily been used for super 8 and some 16mm applications, mostly using cassette projection.

There is no doubt that polyester base offers distinct and intrinsic advantages over triacetate base, advantages that would be particularly suitable in other motion picture applications. Polyester has greater tear and tensile strength — greater toughness which makes it less apt to suffer surface abrasions on the base side. It is also dimensionally more stable, even under adverse handling conditions.

But the industry also has some concerns over polyester film base. Splicing cannot be done by conventional means, and rejuvenation of base scratches cannot be done satisfactorily. An additional concern is the greater mechanical strength of polyester film, which could make it more likely to damage equipment; this particular concern was suspected to have a psychological basis in that in many cases there were only unfounded rumors of damage.

To anticipate a possible switch of the motion picture industry from triacetate to polyester base, in recognition of the inherent advantages of polyester, would require that Agfa-Gevaert as a film manufacturer be ready with the required manufacturing capacity. Agfa-Gevaert, therefore, decided to carry out some thorough market research with the intent to measure the industry's awareness of polyester, the experience with polyester in the market, and especially to investigate the readiness of the motion picture industry to accept a more widespread use of polyester film base for various applications which are now still on triacetate base.

Agfa-Gevaert had this market survey conducted in the U.S. This market was selected because the U.S. motion picture industry plays a leading role in the world motion picture business. This survey was not limited to the laboratories handling the film but also included the end-users of the product: distributors and exhibitors.

For maximum objectivity, Agfa-Gevaert decided to have the survey carried out under anonymous sponsorship. They selected a well-known independent market research organization, the Opinion Research Corp., a division of A.D. Little Inc. of Princeton, N.J. The survey was conducted between September and November 1978. The following is a report on the most relevant findings of this market survey.

Polyester Film Base in the U.S. Motion Picture Laboratories

Seventy laboratories in all parts of the country were contacted. Only the labs which claimed to have some experience with, or knowledge of, polyester base film qualified for an interview. Personal interviews were conducted with 44 labs. This constitutes about 30% of the total number of U.S. labs, excluding the TV in-house labs and the very small one-man operations. In order to bring the individually expressed opinions into a more realistic relation with the general consensus of opinion in the market, a weighting factor was introduced based on the size of the laboratories. To avoid indiscrete questions about the value of turnover or volume of film used, it was decided to separate the labs into three categories, based mainly on their number of employees and their status in the industry (Table I).

A contribution received on 27 July 1979 from George J. Van Schil, Marketing Motion Picture Products, Agfa-Gevaert, N.V., Septestraat 27, B-2510 Mortsel, Belgium. Agfa-Gevaert and Opinion Research Corp., a division of A.D. Little Inc., Princeton, NJ 08540, are the sources of the information presented in this paper. Reprint permission was given by the British Kinematograph, Sound and Television Society. The paper also was presented before the BKSTS and at the Meeting of the Association of Cinema and Video Laboratories, October 1979, in Los Angeles.

Table I. Laboratory size-weighting factors.

Lab size	Number of employees	Number of labs	Percent of total in size group	Weighting factor
Small	less than 50	25	20%	2
Medium	50–200	14	77%	5
Large	more than 200	5	84%	9

Table III. Film base handling preferences of laboratories.

Film format	Polyester better	Triacetate better	Both equal	No opinion
16/S8-35/S8 16mm	37%	43%	6%	14%
35mm	18%	46%	11%	25%

The weighting factors were carefully selected. Indeed, the fact that some of the small labs may have a turnover 100 or 200 times less than a large lab does not necessarily make their opinion 100 or 200 times less important.

Polyester Base Experience

All the labs were first asked to give details of their experience with polyester base film (Table II). The following facts merit attention. Most of the experience with color print film on polyester base was with the super 8 and 16mm formats. The 30% having experience with other stocks on polyester base included sound negative and various duplicating films. Most labs had their polyester experience with 120-μm base; a minority also had experience with 90- or 100-μm base; less than 20% did not care or did not know about the base thickness.

Handling of Polyester Base Film in the Laboratories

When asked what they considered better to handle in their lab, polyester or triacetate film base, the opinions shown in Table III were given. The interesting point here is that there is no majority favoring triacetate and that in fact there are quite a number of people who think that both base materials are equal or who have not yet formed an opinion. When asked to broaden their views, that is, not only to consider their own handling problems but also to give consideration to overall use and to the needs of their customers and other users, the lab executives came to even more interesting conclusions (Table IV).

The labs that considered polyester better for general use (59%) were asked which advantages of polyester base they prefer most. Their answers are shown in Table V. Those who considered triacetate better for general use (22%) were asked which disadvantages of polyester they most object to. Their answers are shown in Table VI.

In order to get a better understanding of how all the labs rate the advantages and disadvantages of polyester they were all given the characteristics of polyester and again asked what they considered better, polyester or triacetate. Table VII lists the percentage answers to those questions. This table certainly indicates that many laboratories are well acquainted with the characteristics of polyester base. Characteristics such as "less likely to break" and "less risk for perforation damage" which are related to tensile or tear strength have been introduced to avoid the frequently occurring confusion between tear and tensile strength. On less important properties such as electrostatics there appears to be some ignorance. Almost all the labs feel that polyester is superior in terms of tensile or tear strength, but at the same time 88% expressed their concern about the same characteristic because of the possible damage to their equipment.

All the labs were also asked what equipment was considered to be most threatened by polyester film (Table VIII). It is rather surprising that 47% of the labs think of possible damage to their processors, considering that 68% are using polyester leader film in those processors, and all admitted that they had used or are using some form of color print film on polyester base.

Printing

It goes without saying that all the labs are using continuous printers for the bulk of their work. More important is the finding that 100% of the labs use the same printers for polyester and triacetate base and 84% claim to make no changes in their printing procedures for polyester.

Processing

Ninety-four percent of the labs use the same processing equipment for polyester or triacetate base. Eighty-seven percent of those labs claim not to change their procedures or adjust their machines when they use polyester.

Other Handling Concerns in Laboratories

Apart from processing and printing, all labs were asked if they had concerns other than printing and processing when they were handling polyester film. Their answers: 70% said yes, they had more concerns while 30% admitted no further concerns. The 70% who had additional worries were asked to specify them. Their answers: 57% mentioned slitting problems, 49% admitted winding and tension problems, and 21% mentioned splicing problems. The latter means that in fact only 15% of *all* labs do have a concern when splicing polyester film. This was somewhat surprising because splicing polyester has often been regarded as a major stumbling block, and consequently splicing was investigated further.

Table II. Experience of laboratories with diverse types of polyester base filmstocks.

Type of stock	Percent of all labs having had experience
Polyester color print	99%
Polyester B/W print	63%
Polyester machine leader	68%
Other stocks on polyester	~30%

Table IV. General use film base preferences of laboratories.

Film format	Polyester better	Triacetate better	No opinion
16/S8-35/S8 16mm	59%	22%	19%
35mm	54%	12%	34%

Table V. Most laboratory-preferred polyester base advantages.

Characteristics	Percent of labs in this class
Tear strength	35%
Tensile strength	30%
Less perforation damage	29%
Longer print life	25%
Does not break	21%
Other characteristics each	<10%

Table VI. Polyester base disadvantages most objected to by laboratories.

Characteristics	Percent of labs in this class
Splicing	57%
Risk equipment damage	50%
Greater tensile strength	31%
Does not break	21%
Slitting	10%
Lower resistance to stretching	5%

Splicing Polyester Film in Laboratories

There are three possible splicing steps in normal laboratory operations: (a) the pre-printing splice, a rawstock splice used to splice all the short ends together; (b) the pre-processing splice, a rawstock splice to make the film fit into the continuous operation of a processing machine; (c) the after-processing splice, where processed film is spliced together to assemble the end product to be delivered to the customer.

The pre-print splice. Sixty-six percent of the labs use polyester short ends in the same way they use triacetate short ends. Most of those who do not use them the same way keep them intact to avoid splicing (Table IX).

Table VII. Polyester base characteristics as rated by percentages of all laboratories interrogated.

Film base characteristics	Polyester better	Triacetate better	Both equal	No Opinion
Tear strength	96%	4%	—	—
Tensile strength	95%	1%	—	4%
Less breaking	96%	4%	—	—
Less perforation damage	85%	4%	10%	1%
Less brittle	67%	4%	17%	12%
Dimensional stability	55%	10%	19%	16%
Less shrinkage	49%	4%	31%	16%
Print life	47%	4%	28%	21%
Splicing	21%	75%	4%	—
Electrostatics	15%	14%	43%	28%
Likely to damage equipment	9%	88%	3%	—

Table VIII. Most threatened equipment with the use of polyester film as rated by percentages of all laboratories interrogated.

Equipment	Percent of all labs
Projectors	54%
Processors	47%
Printers	35%
All equipment	15%
Slitting equipment	8%

Table IX. Splicing methods for polyester short-ends.

Method	Percent of labs
Perforated tape	43%
Buttweld radiant	11%
Ultrasonic	11%
Unperforated tape	7%

Table X. Pre-processing polyester splicing methods.

Method	Percent of labs
Staples	44%
Ultrasonic	30%
Perforated tape	17%

Table XI. After-processing polyester splicing methods.

Method	Percent of labs
Ultrasonic	35%
Perforated tape	34%
Buttweld radiant	18%

Table XII. Experience of film distributors with polyester base materials.

Film format	Percent of distributors
Super 8	50%
16mm	75%
35mm	58%

Table XIII. Film base preference of distributors.

Film format	Polyester better	Triacetate better	No opinion
S8 & 16mm	33%	42%	25%
35mm	25%	33%	42%

The pre-processing splice. Eighty-three percent of the labs splice polyester before they process it; 73% of the labs do not reinforce these splices (Table X).

The after-processing splice. Eighty-three percent of the labs splice and assemble processed polyester film. The rest use other methods or could not specify (Table XI).

As a conclusion to the splicing aspect of polyester we can say that a great majority of the labs do splice polyester and appear to have relatively few problems with it. The tape splice seems to have a relatively good acceptance with laboratories.

Slitting Polyester Film

Somewhat unexpectedly, the concern of the labs about slitting polyester film proved to be important. It was found that 75% of the interviewed labs do slit polyester film, 56% of those claimed to have no problems doing it, but 44% mentioned having difficulties with it. However, two-thirds of these problems just had to do with dull blades.

Identification

A last difference in handling polyester film in laboratories applies to labeling. Thirty-seven percent of the labs label polyester distinctly within the lab and when supplying it to the customer. This is done to warn everybody involved that this film requires special care for handling.

Future Use of Polyester Film

At the end of the interview each lab executive was asked to comment freely on the following final question: What future trends in the development and application of film bases, polyester base in particular, do you see? Thirty-five opinions out of the 44 labs were received, all of which could be classified within the following basic expectations.

1. Only two lab executives expressed firm opposition to more widespread use, and four said not to expect growth because of the handling problems related to it. Two said they did not know whether or not polyester use would be growing.

2. A majority of the lab executives (24) expected a growth in the use of polyester. A minority (5) of those who expect more widespread use claims that it will only grow in super 8 and 16mm. About half of them recognized the advantages of polyester and welcome the expected growth. The other half said that the use of polyester film base only will grow because their customers are pushing them to use it. Most of the same half confirmed that the risk for equipment damage is their main concern. At the end of this report some of these statements will be quoted verbatim as examples representing the above mentioned opinions.

Polyester Film Base and the U.S. Motion Picture Distributors

Twenty-two major film distributors throughout the U.S. were contacted. Only the distributors who claimed to have experience with, or knowledge of, polyester base qualified for an interview. Personal interviews were conducted with 12 distributors. Seven of those are theatrical distributors, of which three are among the largest distribution companies in the U.S. Four distributors were educational, one distributor was primarily specialized in films for airlines.

Experience with Color Print Film on Polyester Base

All 12 distributors had experience with color print film on polyester base (Table XII). Some 75% of distributors also have experience with black-and-white print film on polyester.

Film Base Preference

When asked what film base they considered better for overall use in the various formats the opinions shown in Table XIII were expressed. It is interesting to note the fact that, as with the labs, there is no majority favoring triacetate.

To get a better understanding of how the distributors rate the advantages and disadvantages of polyester, they were also given all the characteristics of polyester base together with questions asking to indicate what they considered better, triacetate or polyester. The answers are given in Table XIV.

The distributors, like the labs, show themselves to be reasonably well acquainted with the polyester base characteristics. On the less important properties of polyester there is more ignorance, but on the well-known advantage of polyester there is a remarkably low number of "don't know" replies. With regard to "print life," distributors rated polyester "better" in far greater numbers than did the labs surveyed. They obviously have a keener interest in such a characteristic than the laboratories.

The distributors were specifically asked whether or not they would see objections to

a more general use of polyester base. They were also invited to speak for their customers. Both their answers are summarized in Table XV. The general opinion was that more than half of their customers' objections would come from TV stations, mainly because of fear of equipment damage.

Splicing

Two-thirds of the distributors repair and splice their own release prints (Table XVI). It is quite significant that even for triacetate, the tape splice is reasonably well accepted in the industry. In fact, over 80% of the distributors claimed that the tape splice was acceptable to them. Of those who do not use tape splices, a majority found their reasons to be the thickness of the tape and the consequent danger of jamming in projection equipment.

Rejuvenation

As with the labs, most of the distributors subcontract their base rejuvenation work to specialized firms. Seventeen percent claimed to do it in-house. There is an apparent lack of knowledge, by labs as well as distributors, with regard to the methods of polyester base rejuvenation used by these subcontractors. There is also evidence of confusion between the methods that are used, as those who claim to know the methods mention the use of solvent as well as the use of a lacquer for polyester. To the best of our knowledge there is no existing solvent to rejuvenate polyester base. Putting a lacquer on the base appears to be the only possible method. Only a few distributors have complaints on the rejuvenation results, mostly the presence of dust and particles (of the lacquer) after rejuvenation.

Identification

Other handling aspects are inspection and labeling. Certainly half of the distributors inspect prints before sending them out and also after their return from the exhibitor. There is no distinction made for polyester in this respect. Nobody labels polyester prints distinctively different.

Polyester Film Base and the U.S. Motion Picture Exhibitors

There are approximately 15,000 theaters spread throughout the U.S., and because only a limited number of questions had to be asked of exhibitors, it was decided to interview by mail. Questionnaires were mailed to approximately 500 exhibitors of which 125 replies qualified for analyzing in this survey; but contrary to laboratories and distributors, experience or knowledge of polyester base films was not considered essential for qualification. Approximately one-third of the exhibitors represented only one theater. The rest represented chains of several theaters, some up to more than 20. The total of this sampling represented approximately 470 theaters or nearly 3% of the U.S. total. The majority of the theaters interviewed exhibit 35mm, and a minority also 16mm. Two-thirds of all theaters were first-run theaters.

Table XIV. Polyester base characteristics as rated by percentages of all distributors interrogated.

Film base characteristics	Polyester better	Triacetate better	Both equal	No Opinion
Tear strength	75%	8%	—	17%
Tensile strength	58%	8%	9%	25%
Less breaking	67%	8%	8%	17%
Less perforation damage	75%	8%	—	17%
Less brittle	59%	8%	8%	25%
Dimensional stability	25%	25%	—	50%
Less shrinkage	41%	17%	—	42%
Print life	67%	8%	8%	17%
Splicing	25%	34%	25%	16%
Electrostatics	16%	17%	17%	50%
Likely to damage equipment	8%	58%	17%	17%

Table XV. Distributors' and their customers' objections to general use of polyester base films.

Answer from:	Object	Do not object	Do not care
Distributors			
S8 & 16mm	8%	75%	17%
35mm	17%	66%	17%
Customers	25%	58%	17%

Table XVI. Splicing methods used by distributors.

Method	Triacetate	Polyester
Cement	75%	—
Tape	38%	50%
Ultrasonic	—	17%
Don't know	—	33%

Table XVII. General use and preference of polyester base.

User sector	Film format	Polyester better	No Opinion
Laboratories	S8-16mm	59%	19%
	35mm	54%	34%
Distributors	S8-16mm	33%	25%
	35mm	25%	42%
Exhibitors	35mm	15%	57%

Table XVIII. Characteristics of polyester base rated "superior" by percentages of laboratories and distributors.

Polyester base characteristics	Laboratories	Distributors
Tear strength	96%	75%
Tensile strength	95%	58%
Less breaking	96%	67%
Less perforation	85%	75%
Less brittle	67%	59%
Print life	47%	67%

Experience

Experience with polyester base was not widespread among theaters: 27% have used it or are using it, 33% never used it, and 40% did not know whether or not they used it. In view of the lack of experience it is quite normal to find that most exhibitors do not know about polyester or said that their film base preference does not matter. This was the opinion of 57% of those who answered, while 28% said they prefer triacetate, and 15% prefer polyester.

Splicing

Our main interest in the exhibitors' opinion was concentrated on how they splice prints and, especially, the acceptance of the tape splice. With regard to triacetate, 94% of all theaters make splices on this type of film. While 81% of these theaters use tape splices, 34% also use cement splices. Once again, this confirms that the tape splice seems to be widely accepted. A vast majority of the users of tape splices apply the tape on both sides. The 19% minority who do not use tape splices gave as their main reasons the lack of tape splicing equipment, the risk of film jamming in the projector, or the fact that a cement splice is cleaner.

The same questions for polyester base film could obviously only be asked of the 27% of exhibitors who had used polyester earlier. Almost the same percentages apply to these exhibitors with regard to the type of splices made on polyester film. Here, the most popular splicing method is also the tape splice. While 85% of the theaters using polyester applied tape splices, 9% said that they used cement. The latter promptly disqualified themselves as a reliable source, because this is obviously an impossibility. Only 3% specified the use of the thermofusion method for polyester splicing.

Inspection and Identification

Other handling in theaters is limited to print inspection, with 93% inspecting prints when received from the distributor, and 49% also inspecting them before returning the prints to the distributor. No distinctively different inspection method is applied for polyester film. A majority (68%) of the exhibitors would prefer to re-

ceive clearly identified polyester film from the distributors. The rest said it did not matter to them.

Conclusion

Most of the laboratories and also many distributors have had experience with polyester base film and are very well acquainted with its main characteristics. Their awareness, knowledge, and experience rate good to excellent. Among the exhibitors there is a lot more ignorance and indifference about polyester base.

A majority of the laboratories feel that polyester base might be better than triacetate for general use in the motion picture industry (Table XVII).

The opinion of the laboratories and distributors that polyester base would be better is based on their awareness and knowledge of its advantages. Indeed, a majority of labs and distributors rated polyester "superior" to triacetate on the characteristics illustrated in Table XVIII. Print life was not so popular with the labs, for obvious reasons, but most of the distributors are well aware of this advantage.

Most distributors have no objections to seeing more general use of polyester base for release prints in all formats. Many also feel their customers would not object to increased use.

In spite of the positive ratings for polyester by the labs, many of them still feel a preference for handling triacetate in their plants. This is no doubt based on their fear of equipment damage and some other handling problems with polyester. The fear of equipment damage certainly remains the main concern throughout the industry and the main source of resistance to polyester. However, 68% of the labs use polyester machine leader. An estimated 50% of the volume in color super 8 are on polyester.

Additional concerns are mainly splicing and slitting. Splicing used to be a major concern. There is an indication that many labs have solved the technical problems. They all seem to splice polyester with satisfactory results; and with distributors and theaters, the end users, it was quite clear that the tape splice was widely accepted in the industry.

The slitting problems, however, turned out to be more serious than we at Agfa-Gevaert anticipated. Although this concern is limited to those laboratories which are working with super 8 and 16mm, it is clear that for many labs it was considered a problem. But, because film manufacturers have acquired a considerable amount of know-how on slitting, Agfa-Gevaert feels that manufacturers should be prepared to share this knowledge with their customers and help them overcome most of these slitting problems.

The concern over rejuvenation is not a major one. Most laboratories and distributors seem to accept the application of a lacquer to the base as a satisfactory method.

A majority of laboratory executives have indicated quite clearly that they expect a gradual move towards a more general use of polyester base. But while many have reservations owing to fear of equipment damage, most lab executives showed a surprising degree of willingness to follow that trend, although ultimately only under pressure from their customers (the distributors).

Some Individual Opinions of Laboratory Executives

To conclude this report we quote some laboratory executives' views verbatim.

Representing the opinion of a minority who do not expect the use of polyester film to grow: "I can't see a great future for polyester because of the equipment damage. This risk for damage offsets the strength and stability of polyester film."

Representing the opinion that the use of polyester base will only grow in super 8 and 16mm: "Anything that is used in a cartridge, like super 8, will become exclusively polyester base."

Representing the opinion of the majority, who expect the use of polyester to grow: "I see more of it being used. Labs have an aversion to using polyester, but the customers want us to use it, even if you tell them triacetate is better." — "I don't know. I only supply what my customers need." — "Customer usage is the deciding factor." — "The only real positive quality of polyester is that it is so strong and long wearing. Therefore, I can see people asking for longer lasting film and we would be forced to service them." — "A good future, provided the quality of the projection equipment is tightened to decrease movement problems." — "More of it is going to be used for release purposes in all formats." — "Eventually it will all be polyester because of longer life and quality."