PRACTICAL POLYMER ANALYSIS

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PREFACE

The aim of this book is to familiarize the reader with the practical aspects of polymer analysis. A wealth of practical detail, including some detailed methods is included. The book covers not only the analysis of the main types of polymers and copolymers now in use commercially, but also the analysis of minor non-polymeric components of the polymer formulation, whether they be deliberately added, such as processing additives, or whether they occur adventitiously, such as moisture and residual monomers and solvent. A broad scheme for the examination of polymers is discussed in Chapter 2.

Practically all of the major newer analytical techniques and many of the older classical techniques, have been used to examine polymers and their additive systems. As so many different polymers are now used commercially it is also advisable when attempting to identify a polymer to classify it by first separating it into pure polymeric and gross non-polymeric fractions (Chapter 2) and then carrying out at least a qualitative elemental analysis and possible a quantitative analysis (Chapters 3 and 4) and then in some cases, depending on the elements found, to carry out functional group analysis (Chapters 6 and 9). If a simple qualitative identification of the plastic is all that is required then it is examined by finger printing techniques, as discussed in Chapter 4, in order ascertain whether a quick identification can be made by comparing its infrared or NMR spectrum, its pyrolysis-gas chromatography pattern or its thermal behaviour with those of authentic specimens of known polymers.

Frequently, however, the identification of a polymer, especially copolymers or terpolymers, is not as simple as this, and it is necessary to obtain a detailed picture of the microstructure of the polymer before an identification can be made.

Examination of polymer microstructure can be an additional means of identifying the polymer or it can be a means of helping to explain particular chemical or physical features of the polymer. In the latter case the type of polymer might already be known but we are looking for structural detail that will explain these properties such as tacticity, geometrical isomerism, regeoisomerism or the types of unsaturated structures, end-groups and branching present; (Chapter 10). In copolymers and terpolymers measurements can be made of comonomer ratio and monomer unit sequences in addition to the measurements discussed above (Chapter 9). Techniques that might be used in addition to elemental and functional group analysis, include spectroscopic techniques such as infrared, NMR, PMR, and systematic investigations by pyrolysis-gas chromatography. Examination for the type of unsaturation present, the nature of side-chain

groups and end-groups, the presence of oxygenated groups such as carbonyl and whether they are macro or micro constituents will all assist in building up a picture of the polymer structure. In many cases, considerable experience and innovative skills are required by the analyst in order to successfully identify polymers by these techniques, and it is hoped that this book will assist the analyst in developing such skills.

Examination for non-polymeric processing additives, monomers, oligomers, residual volatiles, water and catalyst remnants are discussed in Chapter 5.

In Chapter 6 is discussed the fractionation of polymers using classical techniques and more recently developed techniques such as hplc, size exclusion chromatography and supercritical fluid chromatography. Some of these techniques also provide molecular weight data which is discussed further in Chapter 7.

Other polymer physical properties which are discussed include thermal, oxidative or photo-oxidative stability, its combustion properties, measurement of glass transition temperature and other transitions, measurements of crystallinity and melting temperature and of polymer lifetimes under service conditions, (Chapters 11-13).

The book gives an up-to-date and thorough exposition of the present state of the art of polymer analysis and, as such should be of great interest to all those engaged in this subject in industry, university, research establishments and general education. It is also intended for undergraduate and graduate chemistry students and those taking courses in plastics technology, engineering chemistry, materials science and industrial chemistry. It will be useful reference work for manufacturers and users of plastics, the food and beverage packing industry, the engineering plastics industry, plastic components manufacturers, and those concerned with pharmaceuticals and cosmetics.

Before proceeding to the first two chapters, which deal respectively with the determination of elements and functional groups, it would be interest in Chapter 1 to discuss briefly the various types of polymers used commercially, and their properties and applications.

T. R. Crompton

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Figs 1-3	Squirrel, D.C.M., Analyst (London), 106, 1042 (1981).
Figs 5,6	Groten, B., Anal. Chem., 36, 1206 (1964).
Fig 7	Lehman, F.F., Branch, G.M, Anal. Chem., 33, 673 (1961).
Fig 10	Folmer, O.F. Anal. Chem, 43, 1057 (1971).
Table 15	Juvet R.S., Smith, L.J.S., Pang, K.K., Anal. Chem., 44, 49 (1972).
Fig 11,12	Jackson, M.T., Walker, J.Q., Anal. Chem., 43, 74 (1971).
Table 18	Osland, R., Laboratory Practice, 37, 73 (1971).
Fig 13	Brako, F.D., Wexler, A., Anal. Chem., 35, 1944 (1963).
Tables 19,20	Dobies, R.S.J., Chromatography, 40, 110 (1969).
Figs 14,15 & Table 15	Schabon, J.T., Fenska, L.E., Anal. Chem., 52, 1411 (1980).
Figs 16,17 & Table 23	Albarino, R.V., Applied Spectroscopy, 27, 47 (1973)
Fig 18	Soncek, J., Jelinova, E., Analyst (London), 107, 623 (1982).
Fig 19	Drushel, H.V., Sommers, A.L., Anal. Chem., 36, 836 (1964).
Fig 21	Krisher, A., Anal. Chem., 43, 1130 (1971).
Table 27	Simpson, D., Currell, B.R., Analyst (London), 96, 515 (1971).
Tables 29 & 43	Millingen, M.B., Anal. Chem., 46, 746 (1974).

Table 32	Robertson, M.M., Rowley, R.M., British Plastics, 26 January (1960).
Fig 22	Majors, R.E.J., Chromatographic Science, 8, 338 (1970).
Table 36	Denning, J.A., Marshall, J.A., Analyst (London), 97 710 (1972).
Table 37	Lappin, G.R., Zannucci, J., Anal. Chem., 41, 2076 (1976).
Fig 23	Tittareli, P., Zerlia, T., Colli, A. and Ferrari, G., Anal. Chem., 55, 220 (1983).
Table 41	Protivova, J., Posposil, S.J., Chromatography, 88, 99 (1974).
Fig 24	Anderson, D.M.W., Analyst (London), 84, 50 (1959).
Fig 25(a) & Table 45	Cambell, R.H., Wize, R.W., J. Chromatography, 12, 178 (1963).
Fig 25(b)	Schabaum, J.F., Fenska, L.E., Anal. Chem., 52, 1411 (1980).
Fig 26 & Table 46	Vargo, J.D., Olsen, K.L., Anal. Chem., 57, 672 (1985).
Figs 27,28	McCoy, R.N., Fiebig, E.C., Anal. Chem., 37, 593 (1965).
Figs 29-31 & Table 49	Juvet, R.S., Smith, L.S., and Li, K.P., Anal. Chem., 44, 49 (1972).
Tables 56,57	Striechen, R.J., Anal. Chem., 48, 1398 (1976).
Fig 36 & Table 58	Betso, S.R., McLean, J.D., Anal. Chem., 48, 766 (1976).
Table 59	Skelly, N.E., Husser, E.R., Anal. Chem., 50, 1959 (1978).
Fig 40	Roper, J.N., Anal. Chem., 42, 688 (1970).
Figs 43,44	Jeffs, A.R., Analyst (London), 94, 249 (1969).
Table 66	Korenaga, T., Analyst (London), 106, 40 (1981.
Table 73	Baltiste, D.R., Butler, J.P., Cross, J.B., McDaniel, M.P., Anal. Chem., 53, 2232 (1981).
Table 74	Hyden, S., Anal. Chem., 35, 133 (1963).
Fig 45	Brako, F.D., Wexler, A.S., Anal. Chem., 35, 1944 (1963).
Table 75	Stelzer. R.S., Smullin, C.F., Anal. Chem., 34, 194 (1962).

Table 76	Smith, R.M., Dauson, M., Analyst (London), 105, 85 (1980).
Fig 46 & Table 77	Ho, F.T., Anal. Chem., 45, 603 (1973).
Table 78	Kim, C.S.Y., Dodge, A.I., Hay, S., Kawasaki, A., Anal. Chem., 54, 232 (1982).
Table 79	Schleuter, D.D., Siggia, S.S., 49, 2343 (1977).
Fig 47	Fletcher, J.P., Persinger, H.E., J. Polymer Science, A-1, 6, 1025 (1968).
Fig 48 Tables 81-83	Mori, S., Uno, Y., Anal. Chem., 59, 90 (1987).
Table 84	Atkinson, E.R., Calouche A., Anal. Chem., 43, 460 (1971).
Figs 49-51	Mourney, T.H., Smith, G.A., Snyder, L.R., Anal. Chem., 56 1774 (1984).
Figs 52-53	Mourney, T.H., Anal. Chem., 56, 1777 (1984).
Fig 54 & Table 85	Bode, R.K., Benningfidd, L.V., Mowrey, R.A., Fuller, E.N., International Laboratory, 40, Nov/Dec (1981).
Fig 55 & Tables 87-91	Mori, S., Anal. Chem., 53, 1813 (1981).
Fig 56 & Table 92	Mori, S., Anal. Chem., 55, 2414 (1983).
Fig 57	Tally, C.P., Bowman, L.M., Anal. Chem., 51, 2239 (1979).
Fig 58-61 & Table 93	Mori, S., Uno, Y., Suzuki, M., Anal. Chem., 58, 303 (1986).
Fig 62	Williamson, G.R., Cervenka, A., European Polymer Journal, 8, 1009 (1972).
Fig 66	Taylor, W.C., Tung, L.H., Paper presented at 140th Meeting of American Chemical Society, Chigaco, Illinois, September (1961).
Fig 67, 68	Machtle, W., Klodwig, H., Mackromal Chem., 180, 2507 (1979).
Table 94	Williamson, G.R., Cervenka, A., European Polymer Journal, 10, 295 (1974).
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Fig 7 & Tables 105,106	Van Houwlinger, G.D.B., Analyst (London), 106, 1057 (1981).
Table 100	Altenau, H.G., Headley, L.M., Jones, S.O., Rensaw, H.C., Anal. Chem., 42, 1280 (1970).
Table 101	Anderson, D.G., Isakson, K.E., Snow, D.L., Tessari, D.J., Vandenberg, J.T., Anal. Chem., 43, 894 (1971).
Table 102	Barrall, B.M., Porter, R.S, Johnson, D.E., Anal. Chem., 35, 73 (1963).
Fig 72	Porter, R.S., Nickosic, S.W. and Johnson, J.F., Anal. Chem., 35 1948 (1963).
Table 103	Van Lingen, R.L.M., Fresenius, Z., Anal. Chem., 169, 410 (1969).
Figs 73,74	Douglas, J., Timnick, A. & Guile, R.L., J. Polymer Science, A-1, 1609 (1963).
Fig 75 & Table 104	Johnson, D.E., Lyeria, J.R., Horikawa, T.T., & Pederson, L.A., Anal. Chem., 77, 49 (1977).
Fig 76	Sharp, J.L. & Patenson, G., Anal. Chem., 105, 517 (1980).
Fig 77 & Table 108	Anderson, D.G., Isakson, K.E., Vandenberg, J.T., Jao, M.Y.T., Tessari, D.J. & Afremow, L.C., Anal. Chem., 47 1008 (1975).
Fig 78	Tsuji, K. & Kouishi, K., Analyst (London), 99 54 (1974).
Fig 79 & Table 109	Swaraj, S., Ranby, B., Anal. Chem., 47, 1428 (1975).
Fig 80	Peltonen, K., Pfaffi, P. & Itkonen, A., Analyst (London), 110, 1173 (1985).
Fig 81 Tables 110-112	Hammerich, A.D. & Willeboodse, F.G., Anal. Chem., 45, 1696 (1973).
Fig 82 & Tables 113-115	Schleuter, D.D., Siggia, S., Anal. Chem., 49 2349 (1977).
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Table 116	Krishen, A., Anal. Chem., 44, 494 (1972).
Fig 84 & Table 117	Tosi, G., Simonazzi, T., Die Augewandte Makromolecular Chemie, 32, 153 (1973).

Fig 85	Drushell, H.V., Iddings, F.A., Division of Polymer Chemistry, 142nd Meeting American Chemical Society, Atlantic City, September (1962).
Tables 118,119	Lomonte, J.N, Tirpak, G.A., J. Polymer Science, A2, 705 (1964).
Fig 86 & Table 120	Brown, J.E., Tyron, M. & Mandel, J., Anal. Chem., 35, 2173 (1963).
Table 121	Paxton, J.R., Randall, J.C., Anal. Chem., 50, 1777 (1978).
Figure 87	Neumann, E.W., Nadeau, H.G., Anal. Chem., 10, 1454 (1963).
Table 122,123	Anderson, D.G., Isakson, K.E., Snow, D.L., Tessari, D.J., Candleberg, J.T., Anal. Chem., 43, 894 (1971).
Fig 88 & Table 125	Allen, B.J., Elsea, G.M., Keller, K.P., Kinder, H.D., Anal. Chem., 49, 471 (1977).
Fig 89 & Table 126	Brame, E.G., Yeager, F.W., Anal. Chem., 48, 709 (1976).
Fig 90 & Table 127	Blackwell, J.T., Anal. Chem., 48, 1883 (1976).
Fig 91 & Table 129	Voigt, J., Kunststoffe, 54, 2 (1964).
Fig 92	Van Schooten, J., Evenhuis, J.K., Polymer (London), 6, 651 (1965).
Fig 93-95	Lehmann, F.A., Brauer, G.M., Anal. Chem., 33, 676 (1961).
Fig 96	Van Schooten, J., Evenhuis, J.K., Shell Chemical Co., Holland, private communication.
Tables 131,132	Bucci, G., Simmonazzi, T., J. Polymer Science, C-7, 203 (1964).
Fig 97 & Table 133	Van Schooten, J., Duck, E.W., Berkenbosch, R., Polymer (London), 2, 357 (1961).
Fig 98	Veerkamp, M.A., Veermans, A., Makromol. Chemie, 50, 147 (1961).
Fig 99	Porter, R.S., J. Polymer Science, A1, 4, 189 (1966).
Table 134	Paxton, J.R., Randall, J.C., Anal. Chem., 50, 1777 (1978).
Figs 100-102 & Tables 137,138	Sugimura, Y., Takenchi, T., Anal. Chem., 50, 1173 (1978).

Table 141	Porter, R.S., J. Polymer Science, A-1, 4, 189 (1966).
Fig 106	Randall, J.C., J. Polymer Science, 13, 889 (1975).
Fig 107	Binder, J.L., J. Polymer Science, A1, 42 (1963).
Table 143,144	Carlson, D.W., Ransaw, H.C., Altenau, A.G., Anal. Chem., 42 1278 (1970).
Tables 147-149	Vodchnal, J., Kossler, I., Coll. of Czech. Communs. 29, 2428, 2859 (1964).
Fig 110	Luougo, J.P., Salovay, R., J. Applied Polymer Science, 7, 2307 (1963).
Fig 114	O'Mara, H.M., J. Applied Polymer Science, A-1, 8, 1887 (1970).
Tables 157-159	Van Schooten, J., Evenhuis, J., Polymer (London), 6, 651 (1965).
Fig 115	Seger, M., Barrall, E., J. Polymer Science, A-1, 13, 1515 (1975).
Table 160	Ahlstrom, D.H., Liebman, S.A., Abbass. J. Polymer Science, Polymer Chemistry Edition, 14, 2479 (1976).
Figs 124-127	Kullik, E., Kaljurand, M. & Lainberg, M., Laboratory Practice, p73, Jan-Feb (1987).
Fig 128 & Tables 165,166	Shulman, G.P., Polymer Letters, 3, 911 (1965).
Figs 129,130, 133,144 & Tables 167,168	Risby, T.H., Yergey, J.A., Anal. Chem., 54, 2228 (1982).
Figs 131-132 & Tables 169-171	Undseth, H.R., Friedman, L., Anal. Chem., 53, 29 (1981).
Table 174	O'Mara, M.M., J. Polymer Science, A-1, 8, 1887 (1970).
Figs 135-138 & Tables 175,176	Chang, T.L., Head, T.E., Anal. Chem., 43, 534 (1971).
Fig 139	Peltonen, K., Analyst (London), 111, 819 (1986).
Fig 144	Schole, R.G., Bednarczyk, J., Yamanchi, T., Anal. Chem., 38, 331 (1966).
Fig 146	Joseph, K.T., Browner, R.E., Anal. Chem., 52, 1083 (1980).
Figs 151,152	Wohitjen, H., Dessy, K., Anal. Chem., 51, 1470 (1979).
Fig 153	Wohitjen, H., Dessy, K., Anal. Chem., 51, 1463 (1979).

Figs 173,174 & Table 188	Bergmann, K., Polymer Bulletin, 5, 355 (1981).
Figs 176,177	Young, P.H., Spectroscopy International, 1, 50 (1989).
Fig 178	Clampett, B.H., Anal. Chem., 35, 1834 (1963).
Fig 181	Illers, K.H., Heckmann, W., Hambrecht, J., Colloid and Polymer Science, 262, 557 (1984).
Fig 182	Simack, P., Makromal Chemie, 178, 2927 (1977).

CONTENTS