

Alfred Josef Thelen— on the occasion of his seventy-fifth birthday

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Alfred Thelen has made many very important contributions to the field of optical thin films. To honor him on the occasion of his 75th birthday, I prepared a bibliography of his many contributions for the ninth Topical Meeting on Optical Interference Coatings. Here an updated list of Alfred Thelen's books, chapters, papers, conference reports, and patents is presented. © 2006 Optical Society of America
OCIS codes: 000.1410, 000.5360, 310.0310.

Alfred is the son of Alfred Heinrich Thelen and Katharina Butterweck. He was born in Frankfurt, Germany, on 28 March 1929. From 1935 to 1939 he attended a primary school in Niederusel, and then from 1939 to 1947 he attended the Ziehungymnasium (high school) in Frankfurt. In 1949 he matriculated from the Helmholtz Gymnasium, also in Frankfurt. In the years 1949–1955 he studied physics at the Technical School for Higher Education in Darmstadt, one of the great German universities. While there, he was a teaching assistant in experimental and theoretical physics and in applied mathematics. His dissertation was on the subject of conducting antireflection coatings on glass.

In 1950 Alfred married his high school sweetheart Charlotte Brauneck, and in 1952 their daughter Karin was born. In 1955 Alfred went to Santa Rosa, California, to work for the Optical Coating Laboratories Incorporated (OCLI). In 1956 he returned to Germany just long enough to obtain, in 1959, a Ph.D. from the University of Karlsruhe. His thesis was on the lubrication of cylindrical bearings with oil-antifreeze mixtures. Soon after this the Thelens returned to the OCLI in Santa Rosa where, in 1961, he became vice president for Research and Development. Alfred was drawn to America. The free spirit, energy, and optimism of the American way of life impressed him, and he soon became an American citizen. In 1959 his son Alfred Stephan was born.

Then, in 1969, Alfred Thelen joined the Balzers AG in the Principality of Liechtenstein where, in 1976, he became a director and chief of the Thin Films Group. After eight years he returned to the Optical Coating Laboratories in Santa Rosa where he held the positions of senior vice president and director of technology. But eventually he again started to miss his European heritage. This partially explains why Alfred returned to Germany in 1985 to work at Leybold–Heräus in the capacity of research director. In 1990 he became a professor at the University of Kaiserslautern. In the same year he started an optical thin-film interference-coating consulting business in Frankfurt, Germany. In the mid-1990s he became the European representative for the OptiLayer thin-film design software.

Of course, the above-cited dry facts about Alfred Thelen do not begin to do justice to him as a person. I first met Alfred at an Optical Society of America (OSA) meeting in the late 1950s, and we immediately became good friends and always looked forward to our next meeting. We both liked walking, and this gave us the opportunity for long talks. In his youth he decided to study physics and mathematics. But, like most good scientists, he also has other interests. For instance, Alfred likes music, plays the piano, and is quite interested in philosophy. (Not many people will know that in 1984 Alfred found the time to attend a five-day course by Nobel Prize winner Richard Feynman on the “Quantum Mechanical View of Reality,” in which these difficult philosophical ideas were interspersed with sessions on primitive drum playing, yoga, and other eclectic experimental events.) Alfred Thelen has strong ethical values and beliefs. I know that when he became a successful scientist and businessman, he continued to live up to these ideals.

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Received 21 March 2005; accepted 7 July 2005.

0003-6935/06/071319-04\$15.00/0

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Fig. 1. Photograph of Alfred Thelen taken in 1980 at the second OIC topical meeting in Oakland, California.

Alfred has always been very devoted to his family. The Thelens have five grandchildren; Julia, Nicki, and Daniel by their daughter Karin, and Diego and Sancho by their son Stephan. Alfred likes to spend time with his loved ones. This is perhaps why, in the early seventies, Alfred and Charlotte bought a small house on the Isle of Elba. Whenever he could, Alfred would spend time with his loved ones on this beautiful island, sailing or working on the house and enjoying his family's company.

I have tried to compile a bibliography of Alfred Thelen's various publications. My list contains a total of 60 entries and includes 1 book, 9 book chapters, and 32 papers in refereed journals and conference proceedings. Not included in this list are brief conference abstracts. Being an industrial scientist for much of his career, he is, not surprisingly, also the inventor or coinventor on many patents. My search of the U.S. Patent Office database revealed 18 patents. No doubt he also holds many patents in other countries. Let me remind you that this is just an interim list. Knowing Alfred and his enthusiasm for optical thin films, we can expect many more publications from him. In addition to his many written publications, Alfred Thelen has also been asked to present invited papers and short courses in many countries, including the United States, Europe, and China.

Even a very cursory glance at this list of publications will attest to the fact that Alfred Thelen has made many important contributions to the field of optical thin films. Among other things, Alfred has contributed to our knowledge of many diverse thin-

film devices, such as antireflection coatings, reflection and minus filters, edge filters, beam splitters, broad- and narrow-bandpass filters, polarizers, and the like. How many people remember that he wrote what I believe was the first paper on conducting antireflection coatings? I, for one, was always intrigued by the ingenuity of the manufacture of one original product that he had a hand in developing, the circular variable filter. Alfred has also written general articles on applications, devices, and markets for optical coatings and on how to manage an optical-coating operation. But in my mind, Alfred's most important scientific contribution to our field has been to show how the Herpin equivalent index concept can be used to solve various complex design problems such as nonpolarizing beam splitters and edge filters. His book *Design of Optical Interference Coatings*, published by McGraw-Hill in 1988, I believe contains the best and most comprehensive exposition of this subject. This book is now out of print, but a free second edition should soon become available on the Internet.

Alfred Thelen is a fellow of OSA. He has been a member of the society since the early 1960s, and he has taken active part in many of its activities. As far as the Topical Meeting on Optical Interference Coatings (OIC) is concerned, he was the general chairman in 1988, as well as a coeditor of the special issue of *Applied Optics* that presented the results from that meeting. He has also been associated with the organization of many of the design problems presented at these conferences. On many occasions he has agreed to deliver invited talks before different audiences on the state of the art of various aspects of optical thin-film coatings. It is clear that he has done much more than his share of the volunteer work necessary for a community such as ours to thrive.

Unfortunately, for family reasons Alfred Thelen was unable to be at the last OIC topical meeting at which this testimonial to him was presented. We hope that when he sees this text and the list of all his publications in this issue of *Applied Optics*, he will appreciate the very high esteem in which he is held by all scientists and engineers active in the field of optical thin films—a technology to which he has contributed so much.

References

A. Books, Chapters, and Handbook Articles

1. A. Thelen and H. König, "Zur Entspiegelung von elektrisch leitender Glasoberflächen," in *Ergebnisse der Hochvakuumtechnik und Physik dünner Schichten 1*, M. Auwärter, ed., (Wissenschaftliche Verlagsgesellschaft MBH, 1957), pp. 237–240.
2. A. Thelen and H. J. Löffler, "Die Schmierung von zylindrischen Gleitlagern mit Öl-Kältemittelgemischen," in *Abhandlungen des Deutschen Kältetechnischen Vereins Nr. 15*, R. Plank, ed. (Verlag, 1960).
3. A. Thelen, "Design of multilayer interference filters," in *Physics of Thin Films 5*, G. Hass and R. E. Thun, eds. (Academic, 1969), pp. 47–86.
4. A. Musset and A. Thelen, "Multilayer antireflection coatings,"

- in *Progress in Optics* 8, E. Wolf, ed. (North-Holland, 1970), pp. 201–237.
5. A. Thelen, "Qualitätsgrenzen für optische dünne Schichten," in *Ergebnisse der Hochvakuumtechnik und der Physik dünner Schichten* 2, M. Auwärter, ed. (Wissenschaftliche Verlagsgesellschaft MBH, 1971), pp. 261–287.
 6. A. Thelen, *Design of Optical Interference Coatings* (McGraw-Hill, 1988).
 7. A. Thelen, "Optical coatings," in *Ullmann's Encyclopedia of Industrial Chemistry, Vol. A 26* (VCH Verlagsgesellschaft MBH, 1995), pp. 738–741.
 8. B. Danielzik, M. Heming, D. Krause, and A. Thelen, "Overview—thin films on glass: an established technology," in *Thin Films on Glass*, H. Bach and D. Krause, eds. (Springer, 1997), pp. 1–21.
 9. A. Thelen, "Design strategies for thin film optical coatings," in *Thin Films on Glass*, H. Bach and D. Krause, eds. (Springer, 1997), pp. 23–50.
 10. A. Thelen, "The pioneering contributions of W. Geffcken," in *Thin Films on Glass*, H. Bach and D. Krause, eds. (Springer, 1997), pp. 227–239.
- B. Papers and Conference Proceedings**
1. A. Thelen, "Beiträge zur Theorie der Reflexverminderung mit Mehrfachschichten," *Optik* **13**, 537–542 (1956).
 2. A. Thelen and H. König, "Elektrische Leitfähigkeit und Struktur aufgestäubter Indiumoxidschichten," *Naturwissenschaften* **43**, 297–98 (1956).
 3. A. Thelen, "Die Schmierung von Gleitlagern mit Öl-Kältemittelgemischen," *Kältetechnik* **11**, 341–344 (1959).
 4. J. Grant, E. Michel, and A. Thelen, "Recent developments in infrared narrow band filters," in *Infrared Physics, Vol. 2* (Pergamon, 1962), pp. 123–128.
 5. A. Thelen, "The use of vacuum deposited coatings to improve the conversion efficiency of silicon solar cells in space," in *Progress in Astronautics and Rocketry* 3 (Academic, 1962), pp. 373–383.
 6. J. T. Cox, G. Hass, and A. Thelen, "Triple-layer antireflection coatings on glass for the visible and near infrared," *J. Opt. Soc. Am.* **52**, 965–969 (1962).
 7. A. Thelen, "Multilayer filters with wide transmittance bands," *J. Opt. Soc. Am.* **53**, 266–1270 (1963).
 8. A. Thelen, "Circularly wedged optical coatings. I. Theory," *Appl. Opt.* **4**, 977–981 (1965).
 9. A. Thelen, "Equivalent layers in multilayer filters," *J. Opt. Soc. Am.* **56**, 1533–1538 (1966).
 10. A. Thelen, "Design of optical minus filters," *J. Opt. Soc. Am.* **61**, 365–369 (1971).
 11. A. Thelen, "Multilayer with wide transmittance bands, II," *J. Opt. Soc. Am.* **63**, 65–68 (1973).
 12. A. Thelen, "Optical interference coatings," *Appl. Opt.* **15**, 1363 (1976).
 13. A. Thelen, "Optics in Liechtenstein," *Appl. Opt.* **15**, 2979–2982 (1976).
 14. A. Thelen, "Nonpolarizing interference films inside a glass cube," *Appl. Opt.* **15**, 2983–2985 (1976).
 15. A. Thelen, "Avoidance or enhancement of polarization in multilayers," *J. Opt. Soc. Am.* **70**, 118–121 (1980).
 16. A. Thelen, "Nonpolarizing edge filters," *J. Opt. Soc. Am.* **71**, 309–314 (1981).
 17. A. Thelen, "Energy related optical coatings," *J. Vac. Sci. Technol.* **20**, 310–315 (1982).
 18. A. Thelen, "Nonpolarizing edge filters: Part 2," *Appl. Opt.* **23**, 3541–3543 (1984).
 19. A. Thelen and H. Schwiecker, "European trends in optical coatings," in *Optical Thin Films II: New Developments*, R. I. Seddon, ed., Proc. SPIE **678**, 12–13 (1986).
 20. A. Thelen, "Applications, devices and markets for optical coatings," in *Thin Film Technologies II*, J. R. Jacobsson, ed., Proc. SPIE **652**, 316–317 (1986).
 21. H. A. Macleod and A. Thelen, "Optical interference coatings: introduction by feature editors," *Appl. Opt.* **28**, 2697 (1989).
 22. A. Thelen, "1989 trends in optical coatings," *Laser Focus World*, **25**, 130–131 (1989).
 23. A. Thelen, "Large area optical coatings," in *Proceedings of the International Symposium on Optical Coatings*, T. Jinfa and Y. Yixun, eds., (International Academic Publishers, Beijing, 1989), pp. 335–338.
 24. A. Thelen, "Epstein equivalent layer vs. Chebyshev polynomial synthesis in optical interference coatings design," in *Optical Thin Films and Applications*, R. Herrmann, ed., Proc. SPIE **1270**, 2–10 (1990).
 25. A. J. Thelen, "Design of optical interference coatings 1992," in *Thin Films for Optical Systems*, K. H. Guenther, ed., Proc. SPIE **1782**, 2–7 (1993).
 26. A. J. Thelen and R. Langfeld, "Coating design contest: antireflection coating for lenses to be used with normal and infrared photographic film," in *Thin Films for Optical Systems*, K. H. Guenther, ed., Proc. SPIE **1782**, 552–601 (1993).
 27. A. Thelen, "Design of a hot mirror: contest results," *Appl. Opt.* **35**, 4966–4977 (1996).
 28. A. Thelen, "Computer aided design," in Vol. 9 of 1998 OSA Technical Digest Series (Optical Society of America, 1998), pp. 268–270.
 29. A. Thelen, A. V. Tikhonravov, and M. K. Trubetskov, "Push-button technology in optical coating design: *pro et contra*," in *Advances in Optical Interference Coatings*, C. Amra and A. H. Macleod, eds., Proc. SPIE **3738**, 210–220 (1999).
 30. A. V. Tikhonravov, M. K. Trubetskov, A. Thelen, and G. W. DeBell, "Thin film telecommunication filters: automated design and pre-production analysis of WDM filters," in *Proceedings of 2002 IEEE/LEOS Workshop on Fiber and Optical Passive Components* (Institute of Electrical and Electronics Engineers, 2002), pp. 202–207.
 31. A. V. Tikhonravov, M. K. Trubetskov, M. A. Kokarev, and A. Thelen, "Poles representation for group delay and transmittance of WDM filters," in *Proceedings, Optical Coatings: Theory, Production and Characterization. Proceedings of the International Workshop on Optical Coating Technology* (Laboratorio Tecnografico, 2001), pp. 36–40.
 32. A. Thelen, M. Tilsch, A. V. Tikhonravov, M. K. Trubetskov, and U. Brauneck, "Topical Meeting on Optical Interference Coatings (OIC 2001): design contest results," *Appl. Opt.* **41**, 3022–3038 (2002).
- C. Patents**
1. A. Thelen, "Three layer anti-reflection coating," U.S. patent 3,185,020 (25 May 1965).
 2. A. J. Thelen and J. H. Apfel, "Light source," U.S. patent 3,185,834 (25 May 1965).
 3. A. J. Thelen, "Optical coating assembly used as a band pass interference filter reflecting the ultraviolet and infrared," U.S. patent 3,247,392 (19 April 1966).
 4. A. J. Thelen, N. H. Bergfeld, and E. A. Eufusia, "Vacuum coating apparatus utilizing rotating sources," U.S. patent 3,382,843 (14 May 1968).
 5. A. J. Thelen, "Multilayer filter with wide transmittance band," U.S. patent 3,423,147 (21 January 1969).
 6. R. F. Illsley, A. J. Thelen, and J. H. Apfel, "Circular variable filter," U.S. patent 3,442,572 (6 May 1969).
 7. R. F. Illsley, A. J. Thelen, and J. H. Apfel, "Deposition apparatus including rotatable and orbital masking assembly," U.S. patent 3,530,824 (29 September 1970).
 8. R. F. Illsley, A. J. Thelen, and J. H. Apfel, "Method for manufacture of rotatable variable filters," U.S. patent 3,617,331 (2 November 1971).

9. A. J. Thelen, N. H. Bergfeld, and E. A. Eufusia, "Coating apparatus and system," U.S. patent 3,636,916 (25 January 1972).
10. A. J. Thelen, "Interference filter reflecting a certain wavelength band within a certain wavelength range while letting pass other wavelength bands of the range," U.S. patent 3,759,604 (18 September 1973).
11. A. J. Thelen, "Antireflective multilayer coating on a highly refractive substrate," U.S. patent 3,829,197 (13 August 1974).
12. A. J. Thelen, N. H. Bergfeld, and E. A. Eufusia, "Coating method utilizing two coating materials," U.S. patent 3,799,800 (26 March 1974).
13. A. J. Thelen, "Reflection-reducing coating," U.S. patent 3,854,796 (17 December 1974).
14. A. J. Thelen, "Wide-band multilayer interference filter," U.S. patent 3,914,023 (21 October 1975).
15. A. J. Thelen, J. A. Aguilera, J. N. Grant, and G. E. Michel, "Vapor deposition apparatus with mask means," U.S. patent 3,991,707 (16 November 1976).
16. A. J. Thelen, "Non-polarizing thin film edge filter," U.S. patent 4,373,782 (15 February 1983).
17. G. A. Campbell, R. W. Conn, D. M. Goebel, R. Adam, H. Aichert, H. Betz, A. Dietrich, G. Dittmer, K. Hartig, F. Hass, R. Ludwig, M. Mayr, and A. Thelen, "Method and apparatus for the application of materials," U.S. patent 4,885,070 (5 December 1989).
18. B. Vingerling, A. V. Tikhonravov, and A. Thelen, "Optical filter arrangement," European patent 1271198, (2 January 2003).