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TRIBUTE

Frederick Yi-Tung Cho (1939–2011)

His PhD days in Biophysics, the Photosynthesis Lab, and his patents in engineering physics

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Abstract We present here a Tribute to Frederick Yi-Tung Cho (1939–2011), an innovative and ingenious biophysicist and an entrepreneur. He was one of the 4 earliest PhD students [see: Cederstrand (1965)—Carl Nelson Cederstrand; coadvisor: Eugene Rabinowitch; Papageorgiou (1968)—George C. Papageorgiou (coauthor of this paper); and Munday (1968)—John C. Munday Jr. (also a coauthor of this paper)] of one of us (Govindjee) in Biophysics at the University of Illinois at Urbana-Champaign (UIUC) during the late 1960s (1963–1968). Fred was best known, in the photosynthesis circle for his pioneering work on low temperature (down to liquid helium temperature, 4 K) absorption and fluorescence spectroscopy of photosynthetic systems; he showed temperature independence of excitation energy transfer from (i) chlorophyll (Chl) *b* to Chl *a* and (ii) from Chl *a* 670 to Chl *a* 678; and temperature dependence of energy transfer from the phycobilins to Chl *a* and from Chl *a* 678 to its suggested trap. After doing research in biophysics of photosynthesis, Fred shifted to do research in solid-state physics/engineering in the Government Electronics Division (Group) of the Motorola Company, Scottsdale, Arizona, from where he published research papers in that area and had several patents granted. We focus mainly on his days at the UIUC in context of the laboratory in which he worked. We also list some of his papers and most of his patents in engineering physics. His friends and colleagues have correctly described him as an innovator and an ingenious scientist of the highest order. On the personal side, he was a very easy-going and amiable individual.

Keywords Excitation energy transfer · Liquid helium temperature · Motorola company · Biophysics of photosynthesis · Govindjee Lab · Surface wave devices · Acoustic charge transport

This paper was edited by William W, Adams III and Barbara Demmig-Adams, and approved for publication in *Photosynthesis Research* by Demmig-Adams, who added: "This tribute provides a sense of the lasting personal relationships forged in Govindjee's group with its collaborative, innovative spirit."

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Background of the photosynthesis laboratory

Photosynthesis research at the University of Illinois at Urbana-Champaign (UIUC) started in 1947 under what was then called the "Photosynthesis Project" or, as 1931 Nobel Laureate of Physiology or Medicine Otto Warburg called it, the "Photosynthesis Unit" (and the people working there as "Midwest Gang"; see Nickelsen and Govindjee 2011). From 1947 to 1958, this unit was run jointly, but as two independent research groups, by Robert Emerson (1903–1959) and

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Eugene Rabinowitch (1898–1973). Beginning in September, 1961, after a transitional phase of just over 2 years, it was run by Govindjee (one of the authors) and Rabinowitch until the latter's departure to the State University of New York at Albany in September of 1968. We have not included the history related to other pioneers who came later to the Photosynthesis Group, such as Christiaan Sybesma (in Biophysics) and Charles Arntzen (in Botany). For information on Emerson, see Rabinowitch (1961) and Govindjee (2004), for Rabinowitch, see Bannister (1972), Brody (1995), Govindjee (2004), and A. Rabinowitch (2005), and for Govindjee, see Eaton-Rye (2007, 2013) and Govindjee's web page at http://www.life.illinois.edu/govindjee. For information and honors given to Papageorgiou, see Allakhverdiev et al. (2016) and Stamatakis et al. (2016). Furthermore, Ghosh (2004) has captured some of the ambiance in the labs of Govindjee and Rabinowitch, and Ebrey (2015) has captured the essence of the work of Rajni Govindjee. Unfortunately, several former PhD students of the internationally recognized "Photosynthesis Unit" of early days, who also made important discoveries, have passed away; the list is too long, but we mention only those whose Tributes have been published, with the names of their advisors: *Steve Brody* (advisor: Rabinowitch; see Hirsch et al. 2010); *Paul Latimer* (advisor: Rabinowitch; see Latimer et al. 2017); *Prasanna Mohanty* (advisor: Govindjee; see Tiwari et al. 2014, and; Papageorgiou 2014); and *Thomas Punnett* (advisor: Emerson; see Hagar et al. 2011).

Personal life, academic career, associates, and committees

Fred was born on November 19, 1939, in Shanghai, China. He passed away on November 8, 2011, in Mesa, Arizona, USA. Following several years of education at Pui Ching Middle School in Hong Kong, he came to the USA with his parents in 1957 and graduated from Los Angeles High School in 1958. He then entered the University of California at Los Angeles (UCLA), earning a BS in Applied Physics (minor in Mathematics) in February 1962. He subsequently pursued graduate studies at the UIUC and received an MS degree in Physics in June 1963 (advisor: G.M. Almy). In September 1963, he was awarded a US Public Health Service Traineeship in Biophysics to work under Govindjee's guidance. He passed his Qualifying and Preliminary Exams in 1965 and 1966, respectively (see footnote[1] for committee members). All of Fred's doctoral thesis work was done before the end of December 1968, and he received a PhD degree in Biophysics in February 1969 (see Cho 1969). His thesis committee included: Govindjee (Chair), Howard Ducoff, Eugene Rabinowitch, John D. Anderson, Pierce W. Ketchum, and Christiaan Sybesma. At that time, C. Ladd Prosser was Head of the Department of Physiology & Biophysics at the UIUC. Jobie Spencer, a research assistant of Govindjee, helped Fred in instrumentation, Marilyn West and Linda Miller provided assistance in the laboratory, and Stanley Jones (the scientific artist of the UIUC Botany Department) was there to draw nice figures. Fred's dearest friend was Paula Lee who later became his wife; as a medical doctor, she was always there to support Fred. Unfortunately, Paula passed away several years before Fred did. Figure 1 shows a photograph of Fred and Paula Cho with one of us (Govindjee).

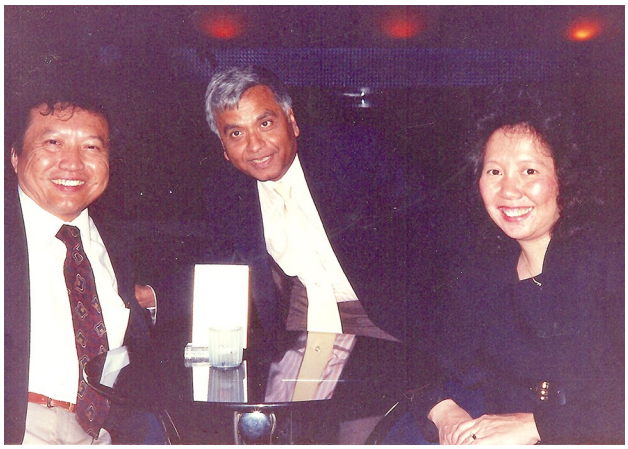

Fig. 1 A 1990 photograph of Fred Cho, Govindjee, and Paula Cho in a French restaurant in the Scottsdale (Arizona) area. Photo by Rajni Govindjee

Research at the University of Illinois at Urbana-Champaign

What was of interest to Govindjee in Fred's background was that he had worked in the area of solid-state physics from March 1962 to September 1963 on problems related to radiation damage in metals and the effect of low temperatures. Fred thought, and Govindjee agreed, that the low temperature devices and the theories used there might be applicable to photosynthetic systems. It was this that attracted Govindjee's interest in having Fred work with him for his PhD. The other two authors (John C. Munday and George C. Papageorgiou) were already pursuing their PhDs under Govindjee.

Fred's doctoral thesis (Cho 1969) focused on spectroscopy of algae down to liquid helium temperature (4 K); he single-handedly built the spectrophotometer and the

[1] Bernard (Bud) C. Abbott, Govindjee, and Howard S. Ducoff served as members of his Qualifying Committee, whereas Govindjee (Biophysics), Floyd Dunn (Electrical Engineering), John D. Anderson (Physiology), Pierce W. Ketchum (Mathematics), and Eugene Rabinowitch (Biophysics) served on his Preliminary Exam.

spectrofluorometer for these measurements (see Cho 1969, pp. 14–23). Fred showed clear resolution of the chlorophyll (Chl) *a* absorption band at 675 nm into two bands at 670 and 678 nm. Since Fred observed a close relationship between the ice-changing phase (cubic to hexagonal form) and the decrease of Photosystem (PS) II fluorescence, he speculated that PS II may be in a more aqueous environment than the PS I! However, Goedheer (1972) challenged this speculation based on his own experiments and on other considerations.

Based on the action (or the excitation) spectra of Chl *a* fluorescence at various emission wavelengths in the green alga *Chlorella pyrenoidosa* and in the cyanobacterium *Anacystis nidulans* (*Synechococcus elongatus* PCC 7942), Fred made the following conclusions[2] concerning the Chl *a species responsible for different fluorescence bands* down to 4 K.

1. Chl *a* 670 is the source of the fluorescence band at 680 nm, F680;
2. Chl *a* 678 nm is the source of the fluorescence band at ~687 nm, F 687;
3. A miniscule amount of Chl *a* (suggested to be the PS II trap), obtaining energy from Chl *a* 686, is the source of F698;
4. A broad fluorescence band at 725 nm (F725) is composed of at least four emission bands: F715-717 (mainly from PS I); F725-730 (mainly from PS I); F735-740 (perhaps from both PS II and PS I); and F750-760 (mainly from PS II).

A more important part of Fred's thesis research dealt with the *temperature dependence of excitation energy transfer* in photosynthetic systems down to 4 K. Fred's experiments led to the following conclusions:

1. Efficiency of excitation energy transfer from Chl *b* to Chl *a*, as well as from Chl *a* 670 to Chl *a* 678, approaches 100% even down to 4 K; this transfer is independent of (or very weakly dependent on) temperature, supporting the fast transfer strong coupling model (see, e.g., Robinson 1967). In all likelihood, this temperature independent energy transfer may have originated in site-energy "disorder" (slow fluctuations) where there is overlap between the emission spectrum of the "donor" and the absorption spectrum of the "acceptor," as shown later by Scholes and Fleming (2000) for energy transfer from B800 to B850 in an anoxygenic photosynthetic bacterium.
2. In contrast to the above, excitation energy transfer from the bulk Chl *a* 678 to the "Trap II" (F695), as well as from phycocyanins (and allophycocyanins) to Chl *a*, is temperature dependent, supporting the resonance excitation energy transfer mechanism, as in the original Förster theory (see, e.g., Förster 1960a, b, 1965, 1967). In all likelihood, this may be because the energy gap between the donor fluorescence and acceptor absorption is much larger than the disorder (slow fluctuations); see, e.g., Scholes and Fleming (2000).

Fred Cho's results and conclusions were published in four original papers (Cho et al. 1966; Cho and Govindjee 1970a, b, c); these have been recognized by many (e.g., Stummann and Henningsen 1980; Foguel et al. 1992; Dutton 1997; Ghosh 2004; Mirkovic et al. 2016). Fred's methods have been employed by others, including Soo Hoo et al. (1986) and van Rensen et al. (1978). Fred's discoveries have been reviewed by Goedheer (1972), Govindjee and Braun (1974), Knox (1975), and in several chapters in books edited by Govindjee et al. (1986) and by Papageorgiou and Govindjee (2004).

It is important to mention that research does not start at zero and de novo. When Fred began doing photosynthesis research, the basic concepts of the two-light reaction and the two-pigment system were in place (see Govindjee et al. [2017] for its "history," so to say). When Fred came to work with Govindjee, his group had already discovered the two-light effect in chlorophyll *a* fluorescence (Govindjee et al. 1960). Carl Cederstrand, Anna Krey, and Louisa Yang (later Ni) had made discoveries via low temperature spectroscopy of photosynthetic systems, but only with liquid nitrogen down to 77 K (see, e.g., Cederstrand et al. 1966a, b; Govindjee and Yang 1966; Krey and Govindjee 1966; Das and Govindjee 1967; Shimony et al. 1967). On the other hand, John C. Munday Jr. and George C. Papageorgiou were busy understanding the relation of fast (then called OIDP, now OJIP; see, e.g., Stirbet and Govindjee 2012) and slow (PSMT) Chl *a* fluorescence transients in algae with different photosynthetic reactions (see, e.g., Govindjee et al. 1967; Munday and Govindjee 1969a, b; Papageorgiou and Govindjee 1967, 1968a, b, 2011). This research included two major concepts: (1) at the "P" level, all electron carriers before and after Photosystem I are in the reduced state (Munday), and (2) slow fluorescence changes include what we now call "state changes" (Papageorgiou and Govindjee 1967, and citations therein). We mention all this because it was, so-to-say, "in the air" at the time Fred was doing his experiments.

[2] During the time Fred was writing his thesis, Govindjee remembers being on Sabbatical at the Centre National Recherche Scientifique in Gif-sur-Yvette, France, working with Jean Lavorel and Martin Kamen. Fred would send him details, in exquisite handwritten text (and hand-drawn figures), covering all possible space in what was then 13-cent aerograms (Govindjee still has 3 of them in his personal collection; see Supplementary Material).

Research in industry and patents in engineering physics

We summarize Fred's work after he left Govindjee's lab and went into industrial research. He first joined Magnavox Company. Later, Fred served in the Government Electronics Division (or Group) of Motorola Company (Scottsdale, Arizona), including as its Head for many years; while there, he filed and was awarded several patents in different areas of physics/ultrasonics and engineering (see http://patents.justia.com/inventor/frederick-y-cho for Abstracts of all the patents that are now listed in Table 1 in the Appendix). Table 1 gives the date each patent was granted, its number, and the title as well as the names of all the inventors. The assignee for most of the patents was *Motorola, Inc*. except for three: patent # 3931597, January 6, 1976: The Magnavox, Inc, where Fred had first worked; patent # 454628, October 8, 1985: The United States of America (USA), as represented by the Secretary of the Air Force; and patent # 4626775, December 2, 1986: USA, as represented by the Secretary of the Air Force. In most of the patents, Fred (Frederick Y. Cho) was the first author; his coauthors (or co-inventors) were several. In alphabetical order, they were: Michael D. Adamo (2X); Robert A. Cook; Cederick U. Darter; Russell J. Elias; Robert F. Falkner, Jr.; (late) Frederick M. Fliegel (6X); Fred S. Hickernell (8X); Thomas S. Hickernell (4X); Bill J. Hunsinger; John R. Joseph; Eric S. Johnson (2X); Paul R. Kennedy; James F. Landers; David E. Leeson; Donald C. Malocha; William J. Martin; Douglas A. Morris; Gerald Norley (2X); David Penunuri (9X); Fred V. Richard (2X); Charles W. Shanley; Raymond L. Sokola; Philip A. Seese; Jose I. Suarez; Joseph W. Walsh (2X); and Dylan F. Williams (2X).

Just to give readers a sense of Fred's research while he was at Motorola, we cite a few of his papers presented at the Institute of Electrical and Electronics Engineers (IEEE) conferences and published in an IEEE journal. His research dealt with manufacturing, properties, and the future of Surface Acoustic Wave (SAW) devices (see *wikipedia*: https://en.wikipedia.org/wiki/Surface_acoustic_wave*)*. We refer the readers to Cho and Hunsinger (1973), Lee et al. (1975), Cho et al. (1976), Janus and Cho (1977), Cho and Richard (1983), and Hickernell et al. (1983) for a better understanding of Fred's SAW research.

Selected testimonials

We provide below a sense of what others thought of Fred during the mid to late 1960s and in recent reminiscences by quoting from letters received by Govindjee.

From a math professor at UIUC (September 15, 1965) "[Fred] was thorough, alert, and faithful in preparation and attendance. I regard him as intelligent, pleasant, reliable, cooperative, and industrious."

From a physical chemistry professor at UIUC (September 15, 1965) "Mr. Frederick Y. Cho belonged among the best students (grade A) in the class and I was particularly impressed by the care he devoted to his problem sets. He took an active part during discussions and showed interest in more mathematical topics which was exceptional in this summer session class."

One of us (*Govindjee) had written to a prospective employer of Fred (April 19, 1967)* "I am very pleased with Fred's work. He has the ability to go right into the problem he takes to solve; you may discuss a project with him on one afternoon and you will find Fred working on it when you come to the lab next morning. When Fred came to our laboratory, we were working on fluorescence of plants at 77 K. Within a couple of months, Fred produced data at 4 K. He obtained precise, reliable and better resolved (than before) emission and excitation spectra (of algae) as a function of temperature (4 to 77 K). Fred is a very careful and methodical experimenter. He has the theoretical background and grasps the fine points of the subject with care… [Further,] Fred gets along well with other members in the laboratory. He has never had any problem in obtaining cooperation from his juniors or from the technical staff. He is a pleasant person and has the proper social outlook toward life."

From a biophysics professor at UIUC (May 6, 1968) "[Fred] has an excellent theoretical background and is a very careful experimenter. I have also been impressed by his solid grounding in physics, which is not very common among our students."

From a plant biology professor at UIUC (June, 1968) "[Fred] has developed a procedure by which he can cool algal cells to the temperature of liquid nitrogen, then return them to room temperature with no apparent diminution to grow normally. A significant discovery in this work makes it possible for him to predict from the spectral properties of a cell suspension whether it has been damaged by the cold treatment."

A footnote about Fred's graduate studies Yes, Fred did have some difficulties in physics, sometimes in finishing his course work and language requirement in a timely fashion. On one occasion he had to leave for an extended period to go to Los Angeles to be with his ailing father, but Govindjee continued his support for which Fred was always very grateful. Fred's difficulties were more than compensated by his ingenious and innovative mind. A driving personality, he was an innovator and an inventor, as well as a "go-getter," and we were all impressed with the speed at which he finished his work, his ingenuity, and his dedication to detail.

One of the several testimonials received is from one of us (*Munday*), a contemporary of Fred. Munday wrote on *April 15, 2017* "Fred Cho was a cheerful companion during our training for scientific research, in the late 1960s in

Govindjee's laboratory (at UIUC). He was a hard worker, diligent, willing to tackle a research problem requiring innovative technique. He was always persistent in questioning, to get to the bottom of issues. He was always willing to engage fellow scientists in discussion. My memory of him is that he was always smiling."

George C. Papageorgiou, also one of us, and Govindjee's first graduate student and collaborator ever since, adds the following testimonial for the Laboratory of Photosynthesis at UIUC: "It was something extraordinary. As I recall, in the middle to the late 1960s, there worked 16 or more grad students and post-docs, under a senior professor Eugene Rabinowitch and a junior professor Govindjee, and later Chris Sybesma, 2 or 3 technicians (notably Linda Miller) maintaining cultures of algae and cyanobacteria, a machine shop for improving instruments, headed by Ervie Ditzler (we called him "Mr. D") and Jobie Spencer, and a secretary, Marion Bedell. The Laboratory equipment included then-unique instruments: a home-built spectrofluorometer capable of measuring room temperature and low temperature spectra, an absorption spectrophotometer equipped with an integrating sphere, and a Warburg-type differential manometer capable of sensitive assays of photosynthetically-evolved oxygen. From the graduate students in the late 1960s, besides Fred Y. Cho, I remember John C. Munday, Prasanna K. Mohanty, Ted Mar, Maarib Bazzaz, Glen Bedell, and from the research associates, Rajni Govindjee, Mrinmoye Das, Gauri Singhal, Danuta Fraçkowiak, Laszlo Szalay, Patrick Williams and Pat Breen. There was a weekly joint seminar every Monday afternoon for both the groups and a second, every Thursday evening for Govindjee's group in Rajni and Govindjee's home (1101 McHenry, Urbana), equipped for that purpose with a green blackboard. Prominent scientists, passing through Urbana, made a point to pay a visit to the Photosynthesis Lab. Among them, I recall Sir George Porter (Nobel in Chemistry, 1967), George Wald (Nobel Prize in Physiology and Medicine, 1967), Warren Butler, and Pierre (& Anne) Joliot. In a few words, the laboratory spirit was about individual and group achievement, sharing and openness and friendliness."

Thomas Hickernell (thickernell@tempeprep.org), who had worked with Fred at Motorola, Inc., wrote on April 18, 2017: "Fred Cho was my supervisor at Motorola in the early 1990s. He started a group to transition surface-acoustic-wave (SAW) technology from government-related applications to commercial applications. I was a part of that group and worked with the group until it was sold to CTS Corporation (formerly **C**hicago **T**elephone **S**upply Company) in 1999. My dad, Fred Hickernell, and Dave Penunuri also worked with that group … *Fred Cho was a man who had lots of ideas*. He often asked me to try out his ideas within my SAW designs, and although many of the ideas didn't work, occasionally we stumbled onto one that did. My guess is that about 10% of his ideas would work, but with as many ideas as he had, we eventually created quite a repertoire of unique technology."

Fig. 2 A 1990 photograph of Fred Cho (on the *right*) with one of us (Govindjee) in Tempe, Arizona. Photo by Rajni Govindjee

We end this Tribute to Fred Cho with another photograph, taken when Govindjee visited him in Arizona in 1990 (see Fig. 2). Fred was at the top of his innovative career—a very successful physicist and an engineer at Motorola, a person with vision and drive, and, above all, he was a great human being. Fred is survived by his son David, who lives in Arizona.

Acknowledgements We thank Greg Scholes for suggestions regarding interpretation of Fred's research, Thomas Hickernell for his contribution, and Sandra Stirbet for preparing Table 1 (see the Appendix) on the patents granted to Fred Cho and his coworkers. Our special thanks go to Jing (Jean) Wang for her crucial support to Fred when he needed it the most. We thank all the staff of the Department of Plant Biology, Department of Biochemistry, and Center of Biophysics and Quantitative Biology for their cooperation in providing information on Fred Cho. All the material used in this article is taken from the personal files in the office of one of us (Govindjee).

Appendix

See Table 1.

Table 1 A list of patents coauthored by Frederick Y. Cho and several others (see alphabetical list in the main text)

US patent	Title	Inventors
Jan 6, 1976; 3931597	Apparatus and method for phase-encoded surface wave devices	F.Y. Cho and B.J. Hunsinger
Aug 23, 1983; 4400640	Temperature stable cuts of quartz	F.Y. Cho and D.F. Williams
Feb 28, 1984; 4450374	Temperature stable surface acoustic wave device	F.Y. Cho and D.F. Williams
May 22, 1984; 4450374	Oxygen plasma passivated and low scatter acoustic wave devices	F.Y. Cho and F.S. Hickernell
Mar 19, 1985; 4506239	Compound surface acoustic wave matched filters	F.Y. Cho and D.F. Williams
Oct 8, 1985; 454628	Conductor structure for thick film electrical device	M.D. Adamo, C.U. Darter, F.Y. Cho
Sep 16, 1986; 4612274	Electron beam/optical hybrid lithographic resist process in acoustic wave devices	F.Y. Cho, J.R. Joseph, P.A. Seese
Dec 2, 1986; 4626775	Radio frequency probing apparatus for surface acoustic wave devices	F.Y. Cho, M.D. Adamo, D.E. Leeson
Mar 24, 1987; 4652290	Method for making optical channel waveguides and product manufactured thereby	F.Y. Cho, F.S. Hickernell, F.V. Richard
Aug 11, 1987; 4686111	Passivated and low scatter acoustic wave devices and method thereof	F.Y. Cho and F.S. Hickernell
Oct 20, 1987; 4701008	Optical waveguide including superstrate of niobium or silicon oxynitride and method of making same	F.V. Richard, F.S. Hickernell, F.Y. Cho
Dec 3, 1991; 5070271	Multi-dimensional acoustic charge transport device	F.Y. Cho and F.M. Fliegel
Dec 17, 1991; 5073807	Method and apparatus for achieving multiple acoustic charge transport device input contacts	F.M. Fliegel, F.Y. Cho, F.S. Hickernell
Jun 2, 1992; 5119172	Microelectronic device package employing capacitively coupled connections	F.Y. Cho, G. Norley, D. Penunuri
Oct 13, 1992; 5155406	Multiple nearest neighbor filter bank	F.Y. Cho, D.C. Malocha, F.M. Fliegel
May 18, 1993; 5212115	Method for microelectronic device packaging employing capacitively coupled connections	F.Y. Cho, G. Norley, D. Penunuri
May 18, 1993; 5212420	Method and apparatus for surface acoustic wave reflector grating	T.S. Hickernell, D. Penunuri, F.Y. Cho
Aug 17, 1993; 5237235	Surface acoustic wave device package	F.Y.-T. Cho, D. Penunuri, R.F. Falkner, Jr
Oct 19, 1993; 5254962	Combined acoustic wave device and ceramic block filter structure	D.A. Morris, R.L. Sokola, F.Y.-T. Cho, C.W. Shanley
Nov 23, 1993; 5265267	Integrated circuit including a surface acoustic wave transformer and a balanced mixer	W.J. Martin, D. Penunuri, J.I. Suarez, F.Y.-T. Cho
Dec 14, 1993; 5270606	Processing robust acoustic reflectors	F.Y.-T. Cho, T.S. Hickernell, D. Penunuri
Mar 22, 1994; 5296824	Low loss wide bandwidth parallel channel acoustic filter	F.Y.-T. Cho, T.S. Hickernell, D. Penunuri
Apr 12, 1994; 5301420	Method for manufacturing a light weight circuit module	F.Y.-T. Cho, R.J. Elias, J.F. Landers
Jul 12, 1994; 5327626	Method for processing robust acoustic reflectors	F.Y.-T. Cho, T.S. Hickernell, D. Penunuri
Feb 14, 1995; 5389806; also 5514626	Apparatus for reducing heterostructure acoustic charge transport device SAW drive power requirements	F.S. Hickernell, F.Y.-T. Cho, F.M. Fliegel
May 30, 1995; 54204472	Method and apparatus for thermal coefficient of expansion matched substrate attachment	F.Y.-T. Cho and D. Penunuri
Jul 4, 1995; D359960	Clip-on earpiece for a portable handset telephone	P.R. Kennedy, F.Y. Cho, R.A. Cook
Dec 12, 1995; 5475311	Ionization gas analyzer and method	F.Y. Cho, E.S. Johnson, J.W. Walsh
Mar 26, 1996; RE35191	Method for reducing heterostructure acoustic charge transport device SAW drive power requirements	F.S. Hickernell, F.Y. Cho, F.M. Fliegel
May 7, 1996; 5475311	Ionization gas analyzer and method	F.Y.-T. Cho, E.S. Johnson, J.W. Walsh
May 7, 1996; 5514626	Method for reducing heterostructure acoustic charge transport device SAW drive power requirements	F.S. Hickernell, F.Y.-T. Cho, F.M. Fliegel

This list was collected and prepared by Govindjee and A. Stirbet from the world wide web (see, e.g., http://patents.justia.com/inventor/frederick-y-cho)

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