ISSN: 1607-3509

Science Bulletin

June 2002/Vol. 34, No. 6
National Science Council, R.O.C.

# Innovative Nanometer Recording Technology — Ultra-High Density Near-Field Optical Disk

"Far-field optics" refers to all conventional optical measurements, observations, or effects in which the measurement distance is far greater than the wavelength of the light used for the measurements. Applications of far-field optics are restricted by the diffraction limit. For instance, held back by conventional far-field optical read-write methods, the only way to increase optical disk recording density is to use the light with a shorter wavelength, or to increase the numerical aperture of the pickup head. Both of these techniques serve to shrink the read-write focused point, and thereby increase recording density and capacity. Introduced in March of this year (2002), blue-light DVD-Blue disk which is capable of storing 27 GB data has increased the capacity of the currently-available ordinary DVD disk from 4.7 GB to a factor of more than five. Nevertheless, optical diffraction effects impose a limit on how small the read-write focused point can be, and the smallest size is typically around half of the wavelength of the light.

The NSC Electro-Optics Task Force, and Ritek Corporation – currently the world's largest producer of optical disks by volume and value – and the research team of Prof. Tsai, Din Ping of the Graduate Institute of Physics, National Taiwan University (NTU), organized an industry-university research team in March 2000 to study near-field optical storage technology. Near-field optics deals with optical observations or effects that are performed at extremely close distance – distance at which diffraction effect cannot occur. Because there are no diffraction interactions in the near field, the diffraction limit does not exist in the near field. The near-field recording bits can be much smaller than the diffraction limit, i.e. half of the wavelength. The recording density and capacity are then increased significantly.

The recording marks of 650 MB CD-R disks and 4.7 GB DVD disks currently on the market are 800 nm and 400 nm, respectively. Recently, the research team led by Professor Tsai has successfully overcome the restrictions of the diffraction limit by using the newest technology of nano-photonics, and developed three kinds of ultra-high density near-field optical disks. These optical disks have record marks less than 0.1 $\mu$m, which is small enough to sharply increase optical recording density and capacity. The single-recording-layer optical disks developed thus far have a capacity in excess of 100 GB, or at least 150 times that of ordinary CD-Rs and 20 times that of ordinary DVDs. Possessing impressive economic benefits and market value, the new high-capacity disks are poised to dominate nanometer storage technology.

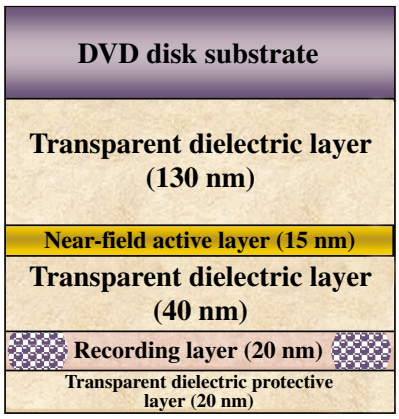


Figure shows the structure of the new near-field optical disks developed at NTU. It is clearly that only a 15 nm near-field active layer and a 40 nm dielectric spacer layer are added in comparison with the ordinary phase-change DVDs. The newest near-field optical disks developed at NTU have measured by the standard DVD testing instrument (Model DDU-1000, Pulstec Inc.) with a wavelength of 637 nm, and numerical aperture of 0.65. In comparison with the ordinary DVDs, the measured carrier-to-noise ratio (CNR) can be more than 34 dB for the 100 nm mark size, but the CNR of the ordinary DVDs is 0 dB when the size of recording marks are less than 250 nm.

The advantages of the near-field optical disks technology are evident. The recording capacity is increased dramatically, but the cost for getting this increase is negligible. There is no need on the change of the design or structure of the optical pickup head of the currently-used optical disks drive for the new near-field optical disks. For instance, they do not require costly blue semiconductor lasers or accompanying blue light read-write pickup lenses. Near-field technology spares the needs to worry about finding appropriate materials for the optical disks and read-write lens, which can have adequate service life under the use of blue laser light. In fact, the sole cost for the big boost in market value and economic effectiveness of the near-field optical disks are the cost of adding two new nanometer-scale layers. The materials of these two thin films and technology for adding them are considerably inexpensive and easily available, respectively.

Being one of the very few laboratories in the world that are capable of producing near-field optical disks presently, the NTU Graduate Institute of Physics' near-field optical disks research team is the international leader in 100 GB near-field optical disks production technology. With the steady support of the NSC, this team is continuing to produce and test various new types of near-field optical disks, as well as studying their structure and material properties, as it strives to make further capacity breakthroughs. The team is also actively cooperating with Ritek Corporation in formulating specifications and preparing for mass production. The NSC hopes that the hard work done in this project will make Taiwan's optical disks industry a global leader in the nanometer record storage medium age.

# High Light of Herbal Medicine Research and Development – Active Fraction and Compound from Cordyceps sinensis

*Cordyceps sinensis* (Clavicipitaceae) (CS), one of the well-known traditional Chinese medicines is a fungus that develops stroma and is found on the larvae of the *Lepidoptera caterpillar*. Recent studies have demonstrated its multiple pharmacological actions such as reducing damage to renal tubules and protecting the $Na^+$, $K^+$-ATPase on cellular membranes, an action which is associated with a reduction in cellular lipid perioxidation. It can decrease chronic renal insufficiency. In rats, it can alleviate hematuria and reduce the elevation of serum creatinine. An extract of CS increases the volume of blood flow in the coronary arteries of experimental animals. It also reduces resistance and pressure in arteries, brain, and peripheral vascular system. CS also promotes platelet formation, helps prevent hypoxia, and acts as a monoamine oxidase (MAO) inhibitor. However, no purified compounds from CS have been used before to evaluate the above-mentioned pharmacological actions.

IgA nephropathy is a chronic disease. Renal function is usually normal at its onset; but, gradual progressive decline in glomerular filtration rate (GFR) occurs in some cases. Extensive long-term follow-up studies in France, Italy, Spain and Taiwan have indicated that 20-30% of patients with IgA nephroapthy develop progressive renal insufficiency 20 years or more after initial discovery of the disease. Unfortunately, at present times, no therapeutic maneuvers have been proved to be consistently effective. Hence there is a pressing need for development of a curative substance. Today, the hypothesis about the pathogenesis of IgA nephropathy (IgAN) is that nephritogenic IgA-immune complexes (IgAIC) go to the kidney to stimulate resting mesangial cells to release cytokines and growth factors. These cytokines and growth factors cause mesangial cell proliferation and release matrix, chemical mediators that lead to the glomerular injury. However, nephritogenic IgAIC in humans is still unknown. To solve this problem previously, we established an *in vitro* model that showed that cultured human MC (HMC) stimulated with interleukin-1 (IL-1) plus IL-6 can cause mesangial cell proliferation, increasing production of chemical mediators and superoxide anion. An *in vivo* model also proved that this culture medium may lead to renal injury with hematuria and proteinuria. Therefore, to fractionate the crude components that can be used in the treatment of patients with IgAN, we cultured HMC, and then an HMC activating model using HMC incubated with IL-1 and IL-6 was established. We fractionated the crude methanolic extracts from fruiting bodies of CS with the use of this in vitro inhibition of HMC activation model as our assay method. In brief, the fruiting bodies were extracted by silica gel column chromatography. One out of 6 column fractions, F-2, significantly inhibited the HMC activation by IL-1 plus IL-6. The acute toxicity test with male Institute of Cancer Research mice showed no liver toxicity or mutagenecity. Then we established an IgAN animal model using R36A (Pneumococcal C-polysaccharide was purified from *Streptococcus pneumoniae*) as antigen and anti-R36A IgA monoclonal antibody to form nephritogenic IgA-IC, which can induce hematuria and proteinuria in mice with IgA deposition in the mesangial area. The mice in IgAN model fed with 1% F-2 in diet has significant reduction of hematuria and proteinuria together with histopathological improvement. This fraction was then purified by silica gel column chromatography and high-performance liquid chromatography, to get a purified compound H1-A, which can suppress the activated HMC and alleviate IgA nephropathy (Berger's disease) with clinical and histological improvement. These results give us a new regimen for the treatment of IgAN in the future.

Systemic lupus erythematosus (SLE) is a chronic autoimmune disease of unknown pathogenesis that is characterized by the overproduction of pathogenic autoantibodies of multiple specificities and is manifested as multiorgan system dysfunction that includes lymphadenopathy, vasculitis, and life-threatening glomerulonephritis. MRL lpr/lpr mice spontaneously develop an autoimmune disease with important similarity of human SLE; it is characterized by the production of autoantibodies (such as anti-DNA antibody), late-onset arthritis, massive lymphadenopathy, and glomerulonephritis. A progressive loss of kidney function develops between 3 and 6 months of age in most animals. Mortality is accelerated such that a 50% mortality rate is observed by 20 weeks of age. Kidney failure is the major cause of premature death.

In an attempt to find out whether H1-A is an immunosuppressive agent and has an effect on IL-2 production from peripheral blood mononuclear cells, and then assessed whether H1-A might be potentially useful in treating human SLE, H1-A was administered to young MLR lpr/lpr mice. Results demonstrated that MLR lpr/lpr mice treated daily with H1-A (40 $\mu$g/kg/d orally) for 8 weeks has a progressive reduction in anti-ds-DNA production (optical density value decreased from $0.172 \pm 0.009$ to $0.112 \pm 0.015$) when compared with the control group (optical density value increased from $0.141 \pm 0.036$ to $0.198 \pm 0.047$). In clinical presentation, the treated group had a reduction in lymphadenopathy, a delayed progression of proteinuria, and an improvement in kidney function. Histological analysis of kidney tissue indicated that H1-A could inhibit the me-

sangial proliferation that was evident in lupus nephritis. However, there was no significnt change in immune complex deposition. The studies reveal that the pure compound (H1-A) may be potentially useful for treating SLE in human patients.

The long-term effect of fraction F-2 and pure compound H1-A still needs further study and this research is in progress.

At a time when high-tech industries are driving economic growth, the technology- and capital-intensive biotech industry is thought to be one of the emerging stars of the 21st century. If Taiwan's biotech industry is to have a fighting chance in international markets, the government, industry, and the academic community must join forces and work as a team to develop this promising area. The NSC is striving to encourage academic-industry joint biotech projects in herbal medicines, and the preliminary findings of the research team headed by Prof. Ching-yuan Lin concerning CS provide a good demonstration of what can be done. We sincerely hope that these and other findings will catalyze the development of a flourishing domestic biotech industry.

# In-car Information System Design and Behavioral Research

In a time when people are using their cars more frequently, and spending significant amounts of time on the road, numerous information systems are being transplanted to cars as a means of saving motorists' time and enhancing efficiency. The best examples of this are the mobile communications and satellite navigation systems now found in many new vehicles. The downside of this trend however is that drivers must attempt to operate complex electronic devices whilst operating the vehicle. Because these new devices can be so much more complex to operate than the actual car, a heavy burden is placed on drivers. The new road transportation management and penalty regulations passed in early 2001 stipulate that the drivers of motor vehicles may not use hand-held mobile phones to make voice or data calls whilst on the road. When even more complex devices such as email, Internet and digital assistant systems, and even complete digital mobile offices are relocated to cars, the operation of these types of information processing equipment will encumber drivers' attention and brainpower to an even greater degree. Whether the burden of operating this equipment will exceed the normal human capacity and/or increase the frequency and severity of traffic accidents, is therefore a matter of great concern.

Accordingly, Prof. Yung-hui Lee of the Department of Industrial Management, National Taiwan University of Science and Technology, has headed an inter-university team of engineering and industrial design specialists, to research "In-car Information System Design and Behavioral Research" with support from the NSC. This project seeks to investigate the possible factors that may influence vehicle safety and traffic accidents. By means of questionnaire surveys, laboratory simulations and road experiments, the project is attempting to achieve the following three goals:

(1) to construct driver behavior and operation burden models for real and visually simulated drivers,
(2) to clarify the mechanisms by which mobile communications devices affect driver behavior, and
(3) to propose improved user interface designs for mobile communications devices.

Specific work conducted by this project includes:

(a) the use of brain waves and behavioral models to investigate how drivers allocate their attention,
(b) the use of the Open GL platform to construct a high-resolution virtual driving environment,
(c) development of an integrated behavioral research vehicle equipped with a digital camera, signal converter, electrocardiograph, electroencephalograph, and multiple computer systems,
(d) the construction of a model of the effect of personality type on drivers' use of mobile phones, and
(e) the development of a specialized mobile communications user interface for motorcycles.

This three-year project began on August 1, 2000, and will run until July 31, 2003. Domestic car manufacturers and digital mobile office suppliers expressed interest in the project from its inception, and the Yue Loong Engineering Center, Taiwan, provided a brand-new Cefiro A33S sedan equipped with a mobile personal assistant to serve as a research platform. Research personnel then installed digital cameras, signal converters, electrocardiograph, electroencephalograph, and computer systems in this vehicle, and have used it to collect data on 'freeway' and 'city' driving. In addition, in order to develop models of driver behavior, the project also constructed a visual virtual driving environment with a human operating interface. This computer model has enabled researchers to probe how perceptions, movements, and cognitive factors affect driving performance.

This project touches on several areas including the development of digital mobile offices, construction of integrated virtual environments, processing of digital image data, and digitization of driving data, and is currently studying driver personality characteristics, operating burden, and allocation of attention resources. It is expected that this project will result in tangible recommendations concerning vehicle operation and traffic safety, as well as proposing user-friendly mobile communications interface design guidelines.

# Formosan Languages on the Verge of Extinction

Ever since Edward Sapir published his well-known paper "Time Perspective in Aboriginal American Culture: a Study in Method" in 1916, scholars have generally accepted his belief that the most linguistically diversified area of a language family is the most likely homeland of that family. Comparative Austronesian scholars generally agree that Taiwan is linguistically the most diversified area of the Austronesian language family, which indicates the greatest time depth of the family. Formosan aboriginal languages retain many archaic features that have been lost in all Austronesian languages outside Taiwan. Comparative Austronesian scholars have all utilized Formosan evidence in reconstructing Proto-Austronesian. Unfortunately, some Formosan languages have become extinct, some are on the verge of extinction, and all the rest will most likely be gone in less than half a century. No Formosan language is being transmitted to the younger generation as a first language. In short, all Formosan languages are doomed to become extinct in the near future.

Over the past four years (January 1998 – December 2001), with financial support from the National Science Council, R.O.C., Dr. Paul Jen-kuei Li of the Institute of Linguistic Study, Academia Sinica, R.O.C., has performed extensive research on Formosan languages on the verge of extinction, including three lowland tribal languages, Pazih, Thao and Kavalan, and two mountain tribal languages, Kanakanavu and Saaroa. Dr. Li collected and analyzed linguistic data of all types (vocabulary, phrases, sentences, texts) under this project. In addition to his first-hand field data, Dr. Li has also gathered written materials previously recorded or collected by the Japanese scholars. Nevertheless, more data must be collected in order (1) to compile a dictionary, (2) to write a reference grammar, and (3) to provide more adequate language material, especially texts, for further study of each of the above five languages.

As for the extinct Formosan languages, most of them (such as Taokas, Papora, Babuza, Hoanya, Kulon, and Qauqaut) have unfortunately perished without a trace, and only a few shreds of information can be salvaged. Dr. Li has searched written documents from Dutch missionaries, European travelers, and Japanese scholars on extinct lowland tribal languages. Among these documents, the most important are the linguistic materials collected by Ogawa and Asai, which are now kept in the archives of Tokyo University of Foreign Studies in Tokyo and Nanzan University in Nagoya. Dr. Li has looked through all of these materials and photocopied the more important ones on his several research trips to Japan. Since a fair amount of vocabulary and written texts are available for Basay, Siraya, and Favorlang, dictionary compilation and interlinear text analysis are possible for each of these three languages.

Among the main focal areas of Dr. Li's research are the peopling of Taiwan and how the Formosan aboriginal peoples dispersed, as based on linguistic, archaeological, and anthropological evidence. Precise dating can only be performed when relevant written documents are available, however.

The goals of the salvage Formosan linguistic study are: (1) to gather as much linguistic data as possible for future study, (2) to understand the grammatical structure of each language, and (3) to clarify the position of each of these languages with regard to each other and with all the other Formosan languages. Dr. Li's research papers issued over the past four years have addressed these three major issues.

Major contributions made by Dr. Li over the past four years include compilation of dictionaries for some lowland tribal languages, including Pazih, Kavalan, Siraya, and Favorlang, and interlinear text analyses for these languages and Basay as well. Dr. Li's dictionary of Pazih was published in 2001; another on Kavalan will be published by the end of the year 2002, both in collaboration with Shigeru Tsuchida. He has published about a dozen papers, mostly on the lowland tribal languages. In addition to linguistic study, Dr. Li has also collected traditional songs in languages on the verge of extinction. In collaboration with ethno-musicologists, he has made possible the publication of CDs and papers on the songs.

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http://nr.stic.gov.tw/ejournal/SciNews/scibulletin.htm
Subscription price for each copy: US$1.00
Payment must be made in US dollars by a check payable to National Science Council.

國　內：每份新台幣25元，訂閱請利用郵政劃撥儲金帳戶0101222-5號
戶　名：行政院國家科學技術發展基金

ISSN 1607-3509
9 771607 350003
GPN: 2009100242