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of wide-spectrum, high resolution, and high linearity. It becomes today's major spectrum analyzer in the range from infrared to ultraviolet wavelength. However, due to limitations of spectral response, grating dispersion feature, and mechanical scanning, parameters such as spectrum working range, resolution, and scanning rate must be compromised to each other. This seriously limited its utilization in several important areas and became a bottleneck problem to further improve the spectrum analyzer.

The research team directed by Prof. Chen utilized multi-grating technology, which sufficiently explored the effective spectral response range of the photonics sensor, folded a 2D-spectrum 5-10 times onto an array imaging plane without mechanical moving parts. This folding extended 5-10 times the measurement scale of infrared and visible light spectrum, solved bottleneck problem, and promoted performance of grating analyzer significantly. The new analyzer holds excellent features as wide spectrum working range, uniform frequency response, high resolution, fast scanning rate without any mechanical moving components, and high reliability etc. Accompanied with more popular application of the high sensitive array-photosensor, this innovative design will become mainstream of digital spectrum analyzer to be developed in the future.

Micro/nano Scale Mechanics and Intelligent Material—The First Creative Research Group in Mechanics

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Keywords: nano smart materials, mechanical oscillator, NEMS, MEMS, nanotube, nanocrystals

As the first Creative Research Group sponsored by Division of Mechanics of Department of Mathematical and Physical Sciences of NSFC, a project team, including two CAS members (Porf. Kezhi Huang, Prof. Wei Yang) and two Changjiang scholars (Prof. Quanshui Zheng, Prof. Daining Fang) from Tsinghua University, focused their research on "Micro/nanoscale mechanics and smart materials", and progressed in the following:

The research group lead by Prof. Zheng proposed in 2002 to carve multi-walled carbon nanotubes as mechanical oscillators in operating frequencies over 1GHz, a range had never been reached before. This innovative work has lead to global research interest. This group also observed for the first time a novel phenomenon, the trans-phonon effect in ultrafast nanomechanical systems. This resembles the transonic effect in aerodynamics and is an intrinsic energy dissipation mechanism. Two means to effectively tune the trans-phonon effect were proposed in their work. Another interesting phenomenon, the self-retracting motion, was also discovered for single crystals. After slipping a nano-flake graphite layer from an island of single graphite crystal into a suspended position and then releaing it, this flake quickly retracted back into the island. These findings could be used to create nanoelectromechanical systems with a wide range of mechanical operating frequency (MHz ~ GHz).

The group of Prof. Yang proposed a 9-crystal cluster model and quantitatively explained the super-plastic extensibility of a bulk nanocrystalline pure copper observed in year 2000. They provided an analytic and computational basis for describing plastic extensibility of nanocrystals and published a series of papers in *JMPS*, the top journal in solid mechanics. They have also proposed a high-efficiency paralleled molecular dynamic computational method and carried out a series of simulations for a ten-million-atom system with a computation complexity of O(n). Prof. Yang further used this method to analyze outburst and termination of stacking faults on nanocrystal under a process of nano indentation, and to study surface nano deposition in a high rate multi-direction rotoblast process.

To analyze mechanical behaviors of larger systems such as NEMS or MEMS, the continuum model is needed. Prof. Huang and his colleagues proposed a nanoscale continuum mechanics theory based on empirical atomic potentials, particularly Tersoff-Brenner potential for carbon systems. Based on this theory they studied various complicated mechanical behaviors during deformation, crack initiation, and flaw initiation of carbon nanotubes. They also investigated pore-size effects on porous medium, extended Rice-Tracey equation and Gurson equation at nanoscale.

In a research of electro-mechanical coupling failure of ferroelectric ceramics, Prof. Yang and his colleagues systematically studied the constitutive relation and collapsing conditions of ferroelectric material. They clarified electric fatigue crack growth mechanism induced by electric domain-switch and further proposed a theory for electric fatigue. Their work was published as "The Failure and Constitutive Laws of

Electro-mechanical Coupling of Ferroelectric Ceramics" on *Comprehensive Structural Integrity of Elsevier.* Prof. Fang designed a new failure parameter - COD of electric induced failure, and set new criterions to justify this parameter. They performed crack experiment for central crack sample under electromechanical coupling load. Their experiments showed that the new criterions could well describe the influence of electronic field on crack load.

Under support of NSFC, the cooperative work of Prof. Zheng and Prof. Huang honored the 2nd class National Science & Technology Award in 2004. The cooperative work of Prof. Yang, Prof. Fang and Prof. Huang honored the 2nd class National Science & Technology Award in 2005.

Transfer Methane to Fragrant Hydrocarbon by Direct Catalyzed Dehydrogenation

Sponsored by NSFC, a research project - "Transfer methane to fragrant hydrocarbon by direct catalyzed dehydrogenation", directed by Prof. Yide Xu, and Prof. Xin Bao from Dalian Institute of Chemical Physics of CAS, honored the 2nd class National Science & Technology Award in 2005.

To transfer catalyzed methane into liquid fuel or chemical material is one of hot spots in today's chemical research. Because of high stability and high symmetry of methane molecule, to activate and transfer this molecule escalates challenges in catalysis science. And how to effectively activate methane molecule and realize carbon-carbon bone coordinated growth is one of key issues.

On the basis of previous research, in 1993, the research team reported their results that, under a condition of continuous flow without oxygen, methane was directly transferred to fragrant hydrocarbon and hydrogen with catalyst Mo/HZSM-5. In the past decade, their research progressed in the following:

1) Their research showed that, till now, Mo/HZSM-5 is still the best catalyst in their experiment.

2) They proposed that the valent state and binding site of Mo species, and acidity as well as pore structure of HZSM-5 molecular sieve are major factors to catalyze methane in a non-oxygen condition. They further disclosed function and mechanism of catalyst Mo/HZSM-5 in the experiment.

3) They studied variations in the binding site and distribution of Mo species during preparation of Mo/ HZSM-5 molecular sieve, and showed that in roasting process, several Mo species migrated in the pore channels of HZSM-5 sieve, and interacted with B-acid center and Al frame of the molecular sieve in their self-designed NMR system (this system holds a Chinese patent). They obtained dynamic variation information of B-acid center of HZSM-5 molecular sieve in near-real reaction conditions, and discussed relationship between the activity of catalyst Mo/HZSM-5 and the whole chemical process.

4) They developed a new type catalyst: Mo/MCM-22, which obviously reduced the selectivity of naphthalene and increased that of benzene in the chemical product. And the anticaking capability of Mo/MCM-22 is better than Mo/ HZSM-5.

5) Based on the research results of interactions between Mo species and B-acid center, stability of catalyst Mo/HZSM-5 was improved, and in the same time, caking products were reduced. It was further disclosed in their research that, in their experiment, methane activation and its transformation to middle product were control processes, further reaction of middle product only needed a few B-acid centers, the leftovers could negatively influence the reaction to produce caking. They also studied inducing period and caking mechanism in their experiments, and proposed 3 types of caking, namely, molybdenum carbide species, caking on molybdenum carbide, and caking of B-acid centers.

6) They proposed and proved coupling process of methane oxidative coupling and methane non-oxygen dehydrogenation. This prolonged catalyst lifetime in their experiment by 3 times.

In the 10-year effort, they published 68 papers on international journals. Till Feb. 2005, their publications were sited by others 815 times, and their first publication in 1993 was sited 157 times. They applied 23 patents, among which 8 were authenticated. They were invited to write summary articles on their work on international catalysis journals and present their work on several international conferences.

DNA Logic Switch for Future DNA Computing

Under funding supports from NSFC, CAS, Ministry of Science and Technology, and Science and Technology Committee of Shanghai, Prof. Chunhai Fan from Shanghai Institute of Applied Physics of CAS cooperated with Prof. Lin He (CAS Member) from Bio-X center of Shanghai Jiao Tong