The Tribochemistry Award

Presented to

Dr. Stephen M. Hsu

In recognition of his outstanding contribution to tribochemistry by The Tribochemistry Technical Committee (Chair: Dr. Keiji Nakayama), Japanese Society of Tribologists (JAST) in September 2019 in “Tribochemistry Hakodate 2019”.

Dr. Stephen Hsu received BS from Virginia Tech, MS and PhD from Pa. State University. During his PhD study under Prof. Elmer Klaus, he was introduced to lubrication and Tribology. His thesis was to measure the reaction temperature under boundary lubrication conditions. Using chemical kinetics monitoring the oil soluble organometallic compounds, he was able to determine the reaction temperatures in boundary lubrication. He received the Captain Alfred Hunt Medal for his work. Ever since then, he has been intrigued with the complexity of lubrication processes. How the lubricant bond to the metal surface? How wear occurs? Upon graduation, he joined Amoco Chemicals to conduct research on lubricant additive development, additive mechanisms and how to apply additives in formulations. After four years, he joined National Institute of Standards and Technology (NIST) to lead the technical effort to establish standards to enable the use of re-refined oils in the US.. In order to link chemical composition to performance, he developed a suite of bench tests with statistical correlation to ASTM Sequence Engine dynamometer tests. The combined results of the testing provided the necessary data set to establish the equivalent Standard adopted by the US Government in 1982.

In 1983, Dr. Hsu established the Tribochemistry Group at NIST to study the molecular interactions of additive with metal surfaces. He pioneered the use of new instrumental techniques, such as laser scattering to study additive agglomeration interactions; HPLC-GFAA for quantitative measurement of organo-metallic species; Synchrotron radiation X-ray absorption spectroscopy to study molecular orientation of adsorbed species together with high resolution FTIR and Laser Raman spectroscopies to probe the basic molecular-surface interactions. These instrumental techniques provided the critical data for him to construct the sequences of boundary lubrication chemical mechanisms. He also designed and constructed a high sensitivity Chemiluminescence instrument to study the oxidation mechanisms and work

with industry to develop novel antioxidants. In the 1990s, he started to work with NSIC consortium on magnetic hard disk technology on monolayer lubrication and molecular lubrication of micro- and nano-scale devices. He conducted nano-scratch tests at that time to demonstrate the effect of plasma emission on enhanced chemical reactivity. During this time, he worked with industry, Department of Energy and Department of defense on advanced lubrication and lubricants for space, defense, and lubrication of non-conventional materials, such as coatings and ceramics.

In 1984, he was appointed the first Division Chief of Advanced Ceramics at NIST, overseeing the US National Ceramics program. In this role, he worked with DOE, DOD, Japan, Germany, and Finland under the International Energy Agency (IEA) to develop standards for ceramics to facilitate international trade of advanced materials. A total of 75 international standards were established by this activity. Besides leading the IEA effort at that time, he has continued to lead the IEA agreement on advanced materials to this date with 9 countries and 30 research institutes/universities.

While maintaining research effort in Tribochemistry, he started working on advance ceramics for adiabatic engines, wear, wear maps, wear prediction, and multilayer ceramics. He participated in the Wear conference and became the Chair in 1998. He also established an industrial consortium of artificial joints replacement materials producers for 7 years, and worked on improved materials, new test methods, surface textures, and lubrication for this industry.

In 2001, he was part of the US Nanotechnology committee ushering in the nanotech world. He developed nano-instruments to probe the physics and chemistry of nanoscale devices.

In 2008, he left NIST and spent 1 ½ years in City University of Hong Kong as Chaired Professor and Head of the Manufacturing Engineering Department, while affiliated with George Washington University where his students worked on surface texture design. In 2009, he returned to GWU to be part of the GW Energy Initiative.

Over the years, Dr. Hsu has worked with various industries in develop measurement technologies, new concepts, and innovations. Of the $25M research funding to date, some 40% came from industries directly. He has mentored over 130 students, visiting professors, and visiting scholars over the years.

He has published over 250 papers, a dozen of books/NIST Special publications, and invited chapters. He has received 10 US patents and has filed 4 world patents which are pending. He has published 3 best of the year papers. And he has delivered over 60 plenary/keynote lectures on various subjects that he is engaged in. He has received many awards, including US Department of Commerce Bronze Medal, Silver Medal, STLE International Award, Captain Alfred E. Hunt Memorial Medal, Al Sonntag Award, and he is a Fellow of STLE and ASME. He serves as Foreign Expert Reviewers on major programs for 7 countries.

Dr. Hsu has contributed to the ITCs and WTCs satellite forums on Tribochemistry for long years from the first time in Tokyo 1995 to Hakodate 2019.

He is indeed a worthy recipient of the world's highest honor in tribochemistry – The Tribochemistry Award for 2019.