INAUGURAL ADDRESS: INTERNATIONAL SYMPOSIUM ON RECENT ADVANCES IN CHROMATOGRAPHY AND MASS SPECTROMETRY

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Dr Ramakrishnan, Founder Member and President, Chromatographic Society of India (CSI), Dr D.V.Prabhu, Convenor of the International Symposium, Recent Advances in Chromatography and Mass Spectrometry, Dr S. Narasimhan, General Secretary of CSI, the recipients of CSI Life Time Contributions Awards and CSI Meritorious Contributions Awards, Ladies and Gentleman:

I am indeed very pleased to be here amongst you this morning, at the inaugural function of this International Symposium. I am particularly pleased to participate in a function that honours my good and distinguished friend, Dr. Balaram, whom I incidentally first met at the campus of IIT, Kanpur in 1966 as a student entering the MSc class. A fifty-year long association indeed!

I feel odd amidst all of you today. Most of you are distinguished practitioners of the science of chromatography and mass spectrometry, far more knowledgeable than me. I have been just a bystander, watching the explosive growth of this branch of science from the side-lines for over fifty years and exploiting the technique, when appropriate, in my research. I do not claim to possess any distinctive expertise in the area. Yet I am, here, in an unenviable position, to address such a distinguished gathering of practitioners and experts. I have been racking my brain as to what I can say that will make some sense to all of you.

Chromatography has been one of the most pervasive and widely used analytical tools in the service of chemistry and biology. Just as the technique has fostered advances in research, advances in the science of chromatography have sharpened and broadened its capabilities and range of applications. From petroleum to drugs, from polymers to proteins, chromatography provides a unique window into the composition and structure of molecules. The battery of GC's and HPLC's that you can see in a petroleum refinery, a petrochemical production plant or in a pharmaceutical industry is also a testament of how critical this technique is to the enterprise of chemistry. Techniques of chromatography literally touches our lives every day, when you pass through an airport, go to a hospital, ensuring the safety of the drugs you consume, are concerned about the quality of air you breath or the water you drink, would like to know which product you consumed is laced with what chemical and whether an athlete who won a gold medal in Olympics won it in a fair or foul manner. Did you smell of rancid butter in the water in a PET bottle or on the walls of your freshly painted house? This is because of higher levels of acetaldehyde in PET (> 50 ppb) or free styrene monomer in the paint (> 1 ppm), all detectable by a headspace GC. As we now use touch most pervasively in everyday life, it will be possible to profile an individual as well as "read-out" his or her lifestyle based on speciation of skin molecules on the surfaces of devices we touch using a mass spectrometer, as was shown recently by a team of scientists at the UC, San Diego School of Medicine and Skaggs School of Pharmacy and Pharmaceutical Sciences.

My own introduction to chromatography was when I began my graduate study fifty years ago. My thesis advisor gave me a single column Varian GC with FID detector, fitted with a 1/4th inch column and asked me to separate the cis and trans isomer of 3-phenyl-2-butene. By the way that was the state of art instrumentation then! Several attempts and months later, I proclaimed failure. Until one day, I brought chemical intuition to the problem of separation. It was common knowledge that silver ions complex preferentially with the cis-isomer. So I treated a silica column with silver nitrate (we used to pack our own columns then) and, lo and behold, I got a beautiful separation of the isomers. We were also witness at that time to a revolution in the making. In the basement of the Wetherill Chemistry Laboratory at Purdue University where Fred McLafferty and his group, built the first interface between a GC and Mass Spectrometer. I had the privilege of watching a maze of wires, tubes, valves, pumps, oscilloscopes and mainframe computer processing information, something that will morph into a compact GC-MS in later years. As a young student it was apparent to me even then that the future of analytical chemistry was essentially engineering and instrumentation.

Since then the science and engineering of chromatography has come a long way. Today, one is able to use the technique with a minimum understanding of the scientific principles, thanks to the engineering of instrumentation and the front-end PC interface with the users.

My next encounter with chromatography was a few years later when I began making polyisobutylenes in the laboratory. We needed to know its molecular weight and molar mass dispersity. There was a new hardware in the laboratory, a Waters GPC, one of the first models ever sold. It occupied the size of a room, 20 x 10 feet and I had to distil 5 liters of THF to run a few samples. The analysis took about a day to complete. The molar mass averages were calculated manually. Today, in my lab, students run a GPC measurement in half an hour. The modern day triple detector GPC's can extract a phenomenal amount of information with one sample injection, namely, absolute average molar mass, weight and number average (without a calibration), molar mass dispersity, intrinsic viscosity, hydrodynamic volume, radius of gyration and Mark Houvink constants, enabling an assessment of whether a chain is a random coil or a rigid rod and is linear or branched. In topologically interesting polymers such as branched polymers, we can estimate the degree of branching, average number of arms per molecule and coil size with great precision. Not only can we determine molecular heterogeneity in synthetic polymers, we can also determine chemical heterogeneity using techniques such as temperature rising elution fractionation (TREF) methods.

The myriad chromatographic techniques that we can access today are mind-boggling. From the simple, yet powerful tools of thin layer and column chromatography which is so widely practiced every day in every organic chemistry laboratory to the most sophisticated techniques such as GC, HPLC, UHPLC, Perfusion Chromatography, SCFC, Affinity Chromatography, Ion Chromatography, Gel and Capillary Electrophoresis, Head Space Chromatography, Pyrolysis GC, Size Exclusion Chromatography, Chiral Chromatography and all the hyphenated tools that allow simultaneous separation and speciation, there is a solution to every separation problem.

Advances in chromatography show no signs of abating. Recent developments in in-vivo probes that can be implanted in living organisms can be used to detect endogenous chemicals or biochemicals in the living systems. Sampling probes can be placed in an animal's brain, large veins or arteries, organs or muscles. Plant physiology and biosynthesis can be studied by inserting probes connected to

chromatography systems into plant tissues. Column sensitivities are increasing continuously with detection limits perhaps to even a single molecule!

In the one hundred and fifteen years since Tsvet demonstrated the first chromatographic principle and seventy-five years since Martin and Synge described the principle of partition chromatography, the technique of chromatography has come a long way. In this symposium you will hear of some of the most contemporary developments in tools and applications from some of the finest practitioners. I do hope the deliberations provide us a peep into the future evolution of chromatography and its power to address increasingly more complex separation problems, with speed, accuracy, precision and lower and lower limits of detection.

I wish the Symposium a great success.