Professor H. Hartnagel

Following his university studies, Hans Hartnagel joined initially the industry where he made his first contributions in the field of microwave tubes such as the introduction of a Toroïdal Hollow-Beam Gun. He then took up university positions where he became involved with new microwave and basic ultra-fast digital component concepts and technological solutions to a variety of engineering and scientific problems. Examples of them include:

- XPS Analysis of (100) GaAs and other Compound Semiconductor Surfaces after Applying Technology-Etchants,
- Plasma Deposition of Amorphous Boron Nitride Insulating Films on Organic Compounds,
- Intelligent Sensors with GaAs for High Temperature Applications,
- Bipolar-Mode Field-effect Transistors with GaAs and other III-V materials,
- Interband-Tunneling in III-V Semiconductor Structures for Multiple-Valued Arithmetic Functions.

Professor Hartnagel published during the period of time he was involved in the above research two books, entitled 1) "Semiconductor Plasma Instabilities" and 2) "Gunn-Effect Logic Devices".

Later on he was involved with passivation techniques for compound semiconductor surfaces and introduced several new device concepts. For this work he obtained the Max Planck Prize together with his co-author Prof. H. Hasegawa. An example out of many projects of this work is the "New Anodic Native Oxide of GaAs and other Compound Materials with Improved Dielectric and Interface Properties".

More recently he was involved with MEMS and sensors based on compound semiconductor structures. Several of his ideas inspired the technology that is nowadays used in modern high-class cars. Examples of them include pressure sensors in tires, radar systems for intelligent cruise control and microwave antennas based on transparent conductor structures on car windows. During the period he performed this work, he published two books, entitled 1) "Semiconducting

Transparent Thin Films" and 2) "High-temperature Electronics". Typical projects related to the above work include:

- Micromechanics on GaAs/AlGaAs for the Fabrication of High Temperature Stable Sensors,
- Thickness-shear resonators in (110) GaAs,
- mm-Wave Antennas for motor-car Radar Applications,
- Phonon engineering: characterization of InGaAs-based 2DEG channels,
- Microwave FBAR Structures Fabricated using Micromachined GaN Membranes
- The "intelligent" car tyre.

The above work was also associated with noise studies, where he published another book entitled "Microwave Noise in Semiconductor Devices", as well as device reliability, where typical projects guided by him were:

- ESD-Degradation Mechanisms of GaAs Microwave Devices and Device Protection,
- Test Structures and Procedures for In-Process Monitoring and Noise-Measurement-based Detection and Analysis of Device Damage caused by ESD,
- Quantum 1/f noise in epitaxial lateral overgrown GaN: piezoelectric effect.

A major effort was also his work on epitaxial problems such as:

- InP in plasma-assisted MBE-Process
- Epitaxial Overgrowth of porous GaAs and InP.

Professor Hartnagel has also made important contributions in the development of Schottky Diodes and Hetero-Barrier Varactors for THz applications, particularly also for satellite applications of the European Space Agency. These include:

- New Approach to the Design of Schottky Barrier Diodes for THz Mixers,
- Anti-Parallel Planar Schottky Diodes for Sub-harmonically Pumped Mixer,
- Nano-Technology-Device Prospects: Quantum Dots and Transistors for Ultra-compact Integration and Terahertz Analogue Applications.

His early experience with microwave tubes allowed him to also contribute to the field of multipactor and corona problems with communication satellites and there also the problems of Passive Intermodulation:

- Corona discharge: Towards a simulation tool for arbitrary geometries,
- Passive Intermodulation Generation at Waveguide Junctions,
- Multipactor problems to be avoided by appropriate design.

Finally, his contributions also addressed the field of modern quantum electronic concepts and electron field emission:

- Microwave Applications of Carbon Nanotubes,
- Quantum-Size Resonance Tunneling in the Field Emission Phenomenon,
- Magneto-transport properties of two-dimensional electron gas in AlSb/InAs quantum well structures designed for device applications.

The examples quoted above support the fact that Professor Hartnagel made a wealth of important contributions during his professional research life. He published more than 700 papers in scientific journals, mostly with refereeing involved, and brought more than 140 young people to their doctorate.

At the same time he was responsible for setting up numerous opportunities for university students to allow them studying and researching in countries with different national language. This was motivated by the fact that he was convinced that scientific and engineering is more successful when it is based on international experience, along the lines of his own career.