Contribution of the Institute of High Pressure Physics of the Polish Academy of Sciences (Unipress) to semiconductor physics.

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A significant influence of high pressure on semiconductor crystals is reflected by

- changes in interatomic distances, which causes the evolution of band structures, sometimes leading to quantum phase transitions.
- changes in thermodynamic potentials in multiphase systems containing semiconductor crystals, which may allow the synthesis of these crystals under near-equilibrium conditions.

Unipress was created 50 years ago (1972) by separation of the Laboratory of Pressure Studies of Semiconductors from the Institute of Physics PAS. An exceptionally strong foundations based on the achievements of the Leonard Sosnowski School of Semiconductors supported by excellent foreign cooperation, in particular with Harvard University, has created a great opportunity for this new Research Center. Its leader, Sylwester Porowski, from the beginning, started to build an original experimental base. The Unipress high pressure equipment quickly gained recognition in the world, and allowed physicists to achieve results appreciated in the scientific community. The most important scientific achievements related to Unipress were:

1. **Pressure studies of narrow gap semiconductors,** including:
   - Opposite pressure dependence of the effective mass in HgTe and InSb and pressure induced gap opening in HgTe confirming inverted band structure of HgTe
   - Pressure induced quantum phase transitions in HgTe–HgCdTe quantum wells
2. **Pressure studies of the impurity/dopant character and recombination mechanisms,** including:
   - Pressure induced anticrossing between impurity states
   - Deep centers with strong lattice relaxation (later known as DX centers)
   - Nature of donors in GaN, resonant states as a source of high electron concentration.
3. **High pressure thermodynamics and crystal growth of GaN,** including**:**
   - Equilibrium curve for GaN-Ga-N_2 system
   - First high quality bulk GaN crystals and homoepitaxial layers
   - Melting and decomposition of GaN: theory and high pressure experiment – NEW
4. **GaN based quantum structures and devices**, including:
   - First Polish (after Nichia and OSRAM) GaN laser
   - First PA MBE GaN laser (2004) and NEW solutions with tunnel junctions
   - First non-polar GaN-AlGaN quantum wells
   - Record mobility in 2DEG in GaN/AlGaN heterostructures
   - Fundamental limit for In content in InGaN-GaN short period superlattices
   - New mechanism of efficient emission from wide GaN-InGaN QWs
5. **Generation of THz radiation in semiconductors**, including:
   - First RT amplification of THz radiation in graphene grating gate structures
   - Low temperature THz emission from GaN/AlGaN heterostructures

Selected results from the above list will be discussed in more detail. At the end, the most relevant new research directions developed at Unipress, such as: high pressure synthesis of h-BN and InN, semiconductor-superconductor (GaN-NbN) heterostructures emitting entangled photons, integrated photonic circuits or THz amplification in semiconductor plasmonic structures (ERC Adv.), will be highlighted.