Thermally detected optical absorption in sophisticated nitride structures

A. Vasson[1], T.V. Shubina[2] and J. Leymarie[1]
[1)]LASMEA-UMR 6602 CNRS-UBP, 63177 AUBIERE CEDEX, France
[2)] Ioffe Physico-Technical Institute, Russian Academy of Sciences, St.Petersburg 194021, Russia

Absorption measurements are a powerful technique, permitting one to study fundamental optical properties of different materials and related heterostructures. However, conventional optical measurements can be hampered for a whole class of structures. For example, it is difficult to provide correct measurements in thick epilayers or in samples, where an empty area is too large. On the contrary, the thermally detected optical absorption (TDOA) is free from these limitations. The method, performed at 0.35 K, is based on the detection of a small increase in the sample temperature, which arises from the creation of phonons at nonradiative recombination, activated by the initial interband optical absorption. This method is sensitive to the absorption of light in metallic inclusions and, to a smaller extent, in other defects.

In the paper, we demonstrate facilities of the TDOA technique in studies of nitrides, which frequently possess complicated microstructure.

Precise TDOA measurements have permitted us to distinguish between the interband absorption in InN and the Mie resonant absorption, taking place within metallic indium clusters embedded into the InN matrix. The resonances arise due to interaction of incident electromagnetic field with plasmon excitation at the surface of the metallic inclusions. As has been demonstrated, the energy position of the Mie resonances depends mostly on the cluster shape and orientation along the wave vector of the field. At the normal incidence, the lowest energy of the resonances corresponds to the clusters extended along hexagonal grain boundaries.

The method has allowed us to study the absorption in separately standing nanocolumns, where the conventional optical absorption technique fails as well. The TDOA spectra registered in the nanocolumn samples exhibit an additional tail extended to lower energies. The tail is ascribed to local regions strained differently as compared with the nanocolumns. Most probably, the regions are joints between the columns characterized by inversed polarity.

The correlation between peculiarities in the TDOA spectra and ones observed in conventional optical absorption, photoluminescence and reflection spectra is discussed.