Preface

Many important effects in solid-state physics and chemistry, optics, spectroscopy and other fields of modern science were either discovered or employed by involving impurity centers. A number of researches related to the problem of impurity or local center in condensed matter have a great impact on the advancement of science and new technologies. It will suffice to mention solid-state lasers, energy transfer and exciton dynamics, nonlinear effects, the control over the properties of semiconductors, information technologies, bioimaging and biosensing, production of new chemical compounds, etc. Active investigations covered three lines — study of just impurity centers, their interactions to one another and their interactions with the host matrix.

Studies of materials at low temperatures play a prominent role in the progress of condensed matter physics and chemistry. The whole field of low-temperature research related to impurity centers developed in the so-called «matrix isolation» physics and chemistry. At the first stage a wide family of unstable species like atoms, radicals, ions was subject of studies. Then the emphasis was focused on the medium effects and solid-state reactions. Study of clusters bridged the gap between studies of isolated centers and condensed matter and a new research field developed into what is now called nanoscience. Metal clusters, «nanodroplets», a wide family of carbon-based structures as fullerens, carbon nanotubes (CNTs) became a hot topic of extensive studies.

This special issue comprises a selection of original research papers to provide some overview of the current research in the field with a focus on low-temperature studies involving impurity centers in cryogenic matrices and nanostructures. Of course a single issue cannot cover the field but we hope that this «snapshot» will bring to the readers an impression of the cryogenic studies of impurity centers, which have became one of the objects of modern physics and chemistry.

The paper by V.G. Manzhelii's group, which pioneered the low-temperature studies of thermal expansion of single-walled carbon nanotube (SWNT) bundles, is concerned with the radial thermal expansion of the N_2-saturated SWNT bundles. A theoretical model for atomic impurity centers in an octahedral void of fullerite C_{60} is presented by M.A. Strzhemechny and I.V. Legchenkova. The paper by V.A. Karachevtsev and A.Yu. Glamazda deals with the Raman spectroscopy of DNA-wrapped SWNT films at temperatures as low as 5 K. The results obtained are compared with those at 295 K.

The problem of H- and D-atoms stabilization and accumulation in Kr–He nanocondensates is studied in detail by R.E. Boltnev et al. using the ESR technique. Very high average concentrations are obtained for H-atoms ($1.2 \cdot 10^{19}$ cm^{-3}) and D-atoms ($3.3 \cdot 10^{19}$ cm^{-3}) in these experiments. The FTIR spectroscopic studies of the mechanisms of H_2 ortho-para conversion in quantum matrix of solid hydrogen doped with Cl-atoms are presented by P.L. Raston et al. The paper by H. Lignell et al. deals with HArF center formation in an Ar matrix via the reaction H + Ar + F at low temperatures. The authors suggest a tunneling mechanism of local reaction of H-atoms with the parent Ar–F centers. The formation of another complex, viz. excimers $(Xe_2H)^*$ in solid Xe doped with H_2 is studied by E. Savchenko et al. using the original two-stage technique of nonstationary cathodoluminescence in combination with the thermally stimulated exoelectron emission.

The paper by C. van der Linde et al. describes an intriguing attempt to solve the problem, which is of high importance for the community using the FT-ICR mass spectrometry to study reaction kinetics, namely, the *in situ* determination of the reactant pressure. O. Byrne et al. address the crystal field effect on the levels of a neutral metal atom in the van der Waals matrix. The paper by A. Serdyukov et al. is concerned with the problem of phase diagram in such a simple molecular matrix as solid carbon monoxide in the pressure range 0–10 GPa and temperature range 30–300 K. A.N. Cherevatova et al. explores in detail the cluster formation from polyatomic molecules in low-temperature condensed systems. A wide family of molecules, like SF_6, CF_4, OCS, etc., is considered.

An area of considerable current interest in fundamental and applied science is organic molecules. The papers by M. Pärs et al., C. Crépin et al. and A.Yu. Ivanov deal with the spectroscopy of such molecules in cryogenic environments. The distribution of purely-electronic linewidths of terrylene single molecules in incommensurate biphenyl crystals is discussed by M. Pärs et al. An observation of stimulated emission from free-base H_2TBP in Ar and N_2 matrices is reported by C. Crépin, et al. which provide additional insight into the site effects and site selectivity. The quantum-chemical calculations at the DFT and MP2 levels of theory and FTIR studies of ribonucleoside uridine (Ur) molecules in the Ar matrix are presented by A.Yu. Ivanov.

The results of numerical simulations and experimental measurements performed using a micro-luminescence confocal mapping of Xe^+ ion implanted diamond are presented by Y. Deshko and A.A. Gorokhovsky with a focus on conversion efficiency of the implanted ions into emitting optical centers.

We cordially thank all the authors for their contributions to the issue.

It is our pleasure that this issue will appear on the date of the golden jubilee of B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine, which together with NASU is the founder of the journal «Low Temperature Physics». The brief chronicle paper dedicated to the event could be found at the end of issue.

Guest editors
Markku Räsänen
Elena Savchenko