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From the chemistry of radicals to molecular spin devices

In recent decades, the world scientific community has been rethinking the possibilities provided by the use of free radicals in chemistry, biology, medicine and materials science. The key to this issue is development of the chemistry of stable organic radicals, which paved the path towards compounds for various functional purposes: radical reagents, initiators for controlled radical polymerization, efficient redox catalysts, spin labels, highly sensitive means for analysis, medical diagnostics and theranostics, building blocks for magnetic and redox-active systems, and key components of organic electronics, spintronics and electric batteries.

The sharp increase in the applied potential of organic radicals was boosted by the development of methods for studying both stable and short-lived paramagnetic compounds, in particular high-spin systems. These methods include, first of all, pulsed EPR techniques, SQUID magnetometry, X-ray diffraction, including protocols using synchrotron radiation sources, scanning electron and force microscopy, and magneto-structural analysis by polarized neutron diffraction. A huge step forward was made by calculation methods, which have formed an efficient tool for modelling and prediction of the magnetic properties of magnetically active systems.

The studies of Russian scientists are making a considerable contribution to the development of chemistry and physics of organic radicals and their applied potential. Russian researchers are traditionally active participants and organizers of conferences devoted to the chemistry of organic radicals, molecule-based magnets, molecular spin devices, and electron paramagnetic resonance. This issue of Russian Chemical Reviews addresses a large area of research related to nitroxide radicals containing an unsaturated moiety at the nitrogen atom, including their physicochemical properties, their computational prediction and fields of their practical application. Among the applications, noteworthy is the design of molecular magnets, development of redox- and photoswitchable molecular systems, redox-active components for organic and hybrid batteries and the use as catalysts and reagents in selective oxidative processes of organic synthesis. Special attention is deserved by a new trend of research related to the design of qubits and qudits based on stable organic radicals and special hybrid systems to solve the problem of scaling and stability in quantum calculations. In all these applied fields, the possibility of varying the structure of stable spin carriers over fairly broad limits will always give rise to new ideas and intentions. We express hope that this issue of Russian Chemical Reviews will contribute to this goal.

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