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Editorial

We are very proud and delighted to introduce this special issue of Radiation Physics and Chemistry (RPC). It is indeed the fruit of an outstanding, collective effort by radiation chemists and physicists, as well as radiation processing and nuclear engineers, who presented their research at the 18th International Meeting of Radiation Processing (IMRP) 2016 in Vancouver, Canada. This valuable issue covers a wide range of reported new results in the field of radiation chemistry, physics, and processing. Eminent scientists carefully selected these invited papers, followed by a thorough reviewing process. This issue presents the selected sixteen invited papers. These papers cover fundamental radiation chemistry mechanisms and kinetics, radiation-induced polymerization and kinetics, radiation effects on synthetic and natural polymers, radiation processing control and quality assurances, radiation-induced preservation of food, radiation sterilization, radiation dosimetry, and radiation synthesis of various fabrics for remediation of nuclear isotopes such as cesium.

Since its dawn, the fundamental and applied sciences of radiation chemistry and physics, radiation processing, and their nuclear applications, have been vital tools in modern technology, specifically, in the fields of advanced nanomaterial manufacturing and processing industries, reliability and risk assessment, environmental engineering, medical diagnostics and radiation therapy, corrosion inhibition in nuclear power plants, and sterilization of medical equipment. One of the remarkable examples of radiation processing is electron beam lithography and its applications in the manufacturing of transistors and other components in the nanoelectronics industry. Other important applications include the sterilization of medical equipment and pharmaceuticals. Irradiation with Low-LET (Linear Energy Transfer) such as the use of 1.17 and 1.33 MeV photons from Co-60, ~ 100-keV to ~ 10 MeV electrons from electron beam accelerators, and high-energy photons ~ 5 MeV from x-ray machines have been used for more than half a century for various applications in radiation processing. The applications of this technology include the synthesis of nano-magnetics and nanomaterials for electronics, biotechnology, such as drug delivery systems, and sensors; fabrication of various fabrics through radiation grafting; and therapy and medical diagnosis. Specifically, we can outline the role of low-LET irradiation processing as follows:

1. The extensive applications in the sterilization of pharmaceutical, medical equipment, and food processing
2. The wide applications in polymer synthesis, polymer modifications such as crosslinking and degradation, and grafting
3. The large scale applications in electron lithography, synthesis of nanostructures for various applications
4. The growing use of electron beam in the remediation of toxic materials
5. Elucidating the mechanisms of the radiation chemistry of DNA, RNA, and proteins, and the role of antioxidants

In conjunction with the low-LET applications, over the last decade or so, the use of high LET irradiation has also been advancing rapidly, and has become a very vital tool in the radiation oncology, synthesis of nanostructures, and investigating the role of heavy particles such as alpha particles in the corrosion of nuclear reactors cores and steam generators. Remarkable achievements have been made in the use of heavy ions particles and protons in cancer therapy. Nano sized transistors and very advanced membranes with nano pores have been synthesized using heavy ion irradiation.

Based on the present pioneering research programs and our knowledge, future trends in radiation chemistry and physics as well as radiation processing and nuclear engineering can be outlined as follows:

1. Light charged particles and gamma radiolysis: Low LET irradiation, as in the case of gamma radiolysis, electron beam irradiation (0.3-10 MeV), and positron irradiation will play major roles in synthesis, manufacturing, and material characterization in nanotechnology. This includes, but is not limited to the following:
   1.1. Electron beam and gamma radiolysis synthesis of nano-magnetic composites
   1.2. Electron beam and gamma radiolysis synthesis of nanogels for drug delivery systems, via intramolecular crosslinking of polymer chains.
   1.3. Electron beam and gamma radiation-induced grafting of nano-tubes for bioengineering applications
   1.4. Electron beam radiation-induced formation of nano-particles
   1.5. Positron irradiation for characterization of nano-structures
   1.6. Synthesis of adsorbents to selectively extract uranium from seawater and for other chemical separations and environmental applications
   1.7. Synthesis of ion conducting membranes for fuel cells
2. Heavy charged particles (i.e. protons and alpha particles):
   2.1. The advancement of radiation oncology requires the application of nano-dosimetry, including measurements of the dose distribution within a single cancer cell. With further understanding of radiation cell killing mechanisms in a mixed LET field, new nano-dosimetry based cell

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survival equations are being developed and benchmarked against experimental results.

2.2. High-LET synthesis of nanostructures and advanced nano-transistors
2.3. Elucidating the radiation chemistry mechanisms and kinetics of interactions of heavy ion charged particles, proton, and alpha particles with matters and theirs applications in selecting new materials for the next generations of nuclear reactors

3. Outer-space radiation chemistry, shielding, and the original of life

The challenges that are facing all of us reside in the following:

1. How can we connect the fundamental of radiation chemistry and physics to the radiation processing, and their applications in cancer therapy, shielding, outer-space radiation, and other advanced manufacturing?
2. How to demonstrate in our research and publications that radiation chemistry and physics, and radiation processing are outstanding and vital tools to both synthesis and degradation and their applications?

Finally, we would like to conclude that the future of radiation chemistry, physics, and processing is very bright with a wide range of applications in pure and applied sciences. The current state-of-the-art offers a unique platform to advance opportunities in fundamental research, medical applications, sterilization, advanced manufacturing, outer space, and old and new generations of nuclear reactors.

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