THE INDUSTRIAL AND ENVIRONMENTAL APPLICATIONS OF ELECTRON BEAMS

edited by
Dagmara Chmielewska-Śmietanko

INSTITUTE OF NUCLEAR CHEMISTRY AND TECHNOLOGY
Warszawa 2015
CONTENTS

PREFACE
Rob Edgecock 5

Chapter 1
INTRODUCTION TO ELECTRON BEAM ACCELERATORS
Zbigniew Zimek 7

Chapter 2
SUCCESSES AND CHALLENGES OF ELECTRON BEAM IRRADIATION APPLICATIONS
Sunil Sabharwal 19

Chapter 3
APPLICATION OF ELECTRON ACCELERATORS IN CABLE INDUSTRY
Grażyna Przybytniak, Zbigniew Zimek 25

Chapter 4
ELECTRON BEAM STERILIZATION
Andrzej Rafalski, Magdalena Rzepna 41

Chapter 5
APPLICATION OF ELECTRON BEAM ACCELERATORS FOR FOOD IRRADIATION
Urszula Gryczka, Wojciech Migdal, Dagmara Chmielewska-Śmietanko 51

Chapter 6
ELECTRON ACCELERATORS APPLICATION IN AIR POLLUTION CONTROL
Andrzej G. Chmielewski, Yongxia Sun 59

Chapter 7
MATHEMATICAL MODELING OF THE ELECTRON BEAM REMOVAL OF THE ACIDIC COMPOUNDS FROM FLUE GASES
Valentina Gogulancea, Vasile Lavric 71

Chapter 8
ELECTRON ACCELERATORS APPLICATION IN WATER AND WASTEWATER TREATMENT
Bumsoo Han, Yuri Kim, Jinkyu Kim 93

Chapter 9
ACCELERATOR TECHNOLOGY FOR ENVIRONMENTALLY FRIENDLY PCB DEGRADATION
Marko Fülöp, Dušan Pajdlauser, Dušan Šiplá, Andrea Šagátová, Peter Hybler 103
Currently there are more than 30,000 particle accelerators in use around the world, in applications ranging from treating cancer to developing better computers. In recognition of this, the European Union Framework Programme 7 supported project EuCARD-2 has created a Network on Accelerator Applications. The objectives of this are to bring together accelerator developers, manufacturers and users to look at existing and possible new applications, identify limitations and study whether technology from the research arena could bring improvements. This work is being carried out through a series of workshops focused on particular applications. The aim in each case is to create new collaborations to tackle issues identified during the workshop and potentially seek further funding to do this from the European Union Horizon 2020 programme.

One of the most important technologies in the applications area is electron beams up to about 10 MeV beam energy. These are used for many applications, including the sterilization of medical products, improving the properties of polymers and other materials and even treating food. In addition, there are a number of newer applications, particularly in the environmental area, including the treatment of contaminants in water, the removal of acid rain creating pollutants in the flue gases of power stations and the possibility of breaking down large organic molecules in agricultural waste to make it usable as bio-fuel. These applications typically require high beam current, very reliable, inexpensive and easy to use accelerators, and meeting these requirements remains a challenge, especially at the higher energies.

Due to the importance of the field, a workshop entitled “The industrial and environmental applications of electron beams” was organized by the Institute of Nuclear Chemistry and Technology in Warsaw on 6th and 7th November 2014. This was jointly sponsored by EuCARD-2 and the Polish Ministry of Science and Higher Education. This workshop has led to the production of this book, to describe the technology used for the acceleration of electron beams, the current applications and the future directions.

Rob Edgecock