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Application of Electron Beam for Preservation Biodeteriorated Cultural Heritage Paper-Based Objects

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Paper provides the ideal nutrient base for mould fungi. Therefore biodeterioration is the most common source of degradation of paper-based materials in museums and libraries. Application of electron beam irradiation in field of cultural heritage preservation is very promising alternative for commonly used ethylene oxide treatment, which is toxic to human and natural environment. Moreover electron beam irradiation can be effectively applied for decontamination of biodeteriorated archives as well as for preventive conservation of large volumes of books in short time. However, to gain public acceptance for radiation methods in large-scale applications many analytical techniques must be used in order to determine possible changes of mechanical, chemical and physical properties of treated objects. Complex study of material properties before and after radiation decontamination should ensure degradation monitoring and process validation.

In this work the influence of electron beam irradiation used for microbiological decontamination process on paper-based objects was evaluated. In this study the connections between electron beam irradiation doses and a change of some chemical, optical and thermal properties of different kinds of paper were established. Electron beam radiation inactivation patterns of different microorganisms present in different paper materials were studied as well.

The samples were exposed to electron beam irradiation using a 10 MeV-10 kW linear electron accelerator "Elektronika" and dosimetric analysis necessary for the proper realization of the process was performed with application of Riso B3 thin-film dosimeters as well as graphite calorimeters.

A wide range of doses from 0.4 kGy up to 25 kGy were studied in order to determine safe and simultaneously effective dose for different papers decontamination with electron beam.

Changes in all samples properties were determined according to the relevant ISO and TAPPI standards.

Microbiological investigation confirmed that dose of 5 kGy completely eliminate all studied kinds of bacteria (gram-positive and gram-negative) as well as fungi in Whatman CHR 1 paper, newsprint paper and office paper. Optical parameters for all studied papers are stable for materials irradiated with doses not higher than 5 kGy, however colour coordinates are still changing with time after irradiation and the effect is being evaluated. Investigation of optical parameters of the paper after irradiation confirmed that coordinate b^* is the optical parameter the most sensitive to electron beam irradiation, what means that paper samples irradiated with high doses became more yellowish.

The control samples and the irradiated samples show similar thermal stability in air on heating.

Taking into account even high levels of the microbiological contamination (in the order of 10^5 CFU/cm²) of paper-based objects electron beam irradiation with doses of 5 kGy ensures elimination of harmful microorganisms and simultaneously prevents paper materials degradation.

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Country/Organization invited to participate

Poland

Primary author: Ms CHMIELEWSKA-ŚMIETANKO, Dagmara (Institute of Nuclear Chemistry and Technology, Poland)

Co-authors: Mr KOPEĆ, Kamil (Warsaw University of Technology, Faculty of Chemical and Process Engineering, Poland); Ms GRYZKA, Urszula (Institute of Nuclear Chemistry and Technology, Poland); Mr MIGDAŁ, Wojciech (Institute of Nuclear Chemistry and Technology, Poland)

Presenter: Ms CHMIELEWSKA-ŚMIETANKO, Dagmara (Institute of Nuclear Chemistry and Technology, Poland)

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