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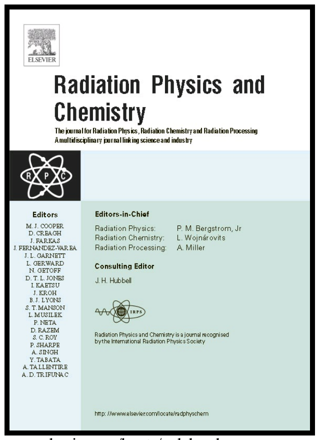

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Influence of Gamma Radiation on Properties of Paper and Textile Fibres during Disinfection

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Abstract
At the present time, gamma radiation is once again being employed for mass disinfection of materials in cultural heritage conservation. Its in-depth and homogeneous effect and also the ability to rapidly treat a large number of items are among the undoubted advantages of this method. However, use of the higher doses of gamma radiation necessary for disinfection entails the risk of damage to organic materials. This work is concerned with the effect of various doses of gamma radiation on cellulosic materials (various kinds of paper and cotton textiles) and on proteinaceous materials (silk). The long-term stability of irradiated samples was also studied during artificial ageing by moist heat, along with the post-irradiation effect. The degree of degradation was studied by means of colorimetry, UV/Vis spectroscopy, viscometry (determination of limiting viscosity number or average degree of polymerization), molar weight distribution and mechanical properties.

Key words: paper disinfection, textile disinfection, gamma radiation, silk, cotton

1 Introduction

Cellulosic (various kinds of paper and textile plant fibres) and proteinaceous (leather, parchment and animal fibres) materials are frequently components of archive funds, artistic-historical collections and also amongst archaeological finds. Deposition of the objects in the soil and also in the atmosphere leads to contamination by various kinds of microorganisms. Microorganisms may cause damage to collection items and thus disinfection is frequently used during conservation process. Agents employed for decontamination items of the cultural heritage must fulfil a number of criteria (sufficient effectiveness, lack of damage to the treated material and the environment, minimum toxicity for human beings). Disinfectant agents can be divided into several groups according to their effectiveness. The most effective agents destroy microbial pathogens and mycobacteria, while others are effective against other bacteria, viruses and moulds. Some disinfectant agents have sporicidal effect, while others have only a limited or no effect in this respect. Disinfectants can be classified according to the means of application (immersion, spraying, gassing ...) or according to the mechanism of their action (physical, chemical and physical-chemical). (McDonnell et al., 1999; McDonnell, 2009) Physical disinfectants are for example gamma radiation, controlled atmosphere of N_2 or CO_2, deep freezing. Chemical methods utilize the action of various types of chemicals – e.g. alcohols, phenols, aldehydes, quaternary ammonium salts, ethylene oxide, or metal nanoparticles (e.g. silver). (McDonnell et al., 1999; Nittérus, 2000)
This work is concerned with studying the effect of ionizing γ-radiation on cellulosic and proteinaceous materials. Disinfection with γ-radiation has the advantage of in-depth action and homogeneous effect and also the possibility of rapid treatment of a large number of items. γ-radiation is high-energy electromagnetic radiation with a wavelength of less than 10^{-11} m, which ensures penetration of the beams deep into the irradiated material. (Hála, 1998; Nittérus, 2000)
Ionizing radiation is commonly used for disinfestation of wood and other materials of collection items. γ-radiation penetrates evenly into the irradiated object and destroys all life forms of insects. The dosage of irradiation required for disinfestation (approx. 0.5 kGy) for most materials in collection items, including paper and textile, does not cause significant changes in the macromolecules structure. (Justa, 1985; Nittérus, 2000)
Disinfection of collection items or archive materials is, however, more problematic, because organisms of a lower biological order are less sensitive to the effects of γ-radiation. Consequently, for the destruction of moulds it is necessary to employ doses of radiation that are an order of magnitude higher (5-18 kGy) than for insects. (Horáková et al., 1984; Saleh et al., 1988) The main mechanism of the effect of gamma radiation on microorganisms is cleavage of DNA, cleavage of other macromolecules and initiation of the formation of free radicals (McDonnell, 2009). The higher doses of radiation necessary for disinfection can than cause changes in the macromolecules structure of cellulosic or proteinaceous fibres, that are manifested in worsening of the