



## Parchment processing and analysis: Ionizing radiation treatment by the REX source and multidisciplinary approach characterization

M. Vadrucci<sup>a,\*</sup>, F. Borgognoni<sup>a</sup>, C. Cicero<sup>b</sup>, N. Perini<sup>c</sup>, L. Migliore<sup>c</sup>, F. Mercuri<sup>b</sup>, N. Orazi<sup>b</sup>, A. Rubecchini<sup>d</sup>

<sup>a</sup> ENEA C.R. Frascati, Lab. APAM, Italy

<sup>b</sup> Dept. Industrial Engineering, Tor Vergata University, Rome, Italy

<sup>c</sup> Dept. Biology, Tor Vergata University, Rome, Italy

<sup>d</sup> Archivio Segreto Vaticano, Vatican City State

### HIGHLIGHTS

- Parchment preservation based on ionizing radiation treatments
- Use of the X-Rays for the bio-degradation removal
- Investigation of damage effects by Light Transmission Analysis

### ABSTRACT

Library material, and thus parchment, is frequently subjected to bio-deterioration processes caused by microorganisms. Fungi and bacteria cause alterations in the parchment inducing, in some cases, even the partial detachments of the surface layer and the loss of any text present on it.

An important contribution to disinfection of the cultural heritage artefacts is given by the use of ionizing radiation.

In this work, a preliminary study on the applicability of X-ray radiation as treatment for bio-deterioration removal is proposed. The results on the microbial growth after different irradiation treatments are shown in order to detect the dose protocol for the bio-degradation removal. Furthermore, the evaluation of the irradiation effects on the parchment microstructure is presented in order to define the applicability of the method on parchment artefacts.

### 1. Introduction

The bio-deterioration of materials consists of a set of unwanted changes of its normal properties caused by the activity of living organisms. There are many agents responsible for bio-deterioration: microorganisms (bacteria, archaea and fungi), in addition to lichens and insect pests. The strategies for the colonization of materials are several and the different bio-deteriorative dynamics cause specific problems in the conservation of artefacts. This holds true for all types of historic items but even for the modern artefacts. The variety of bio-deterioration phenomena observed on materials of cultural heritage (CH) is determined not only by the species of organism responsible for the attack but an important factor is also the composition and nature of the material itself: in library materials damage can occur because of mechanical stress, production of staining compounds or enzymatic action (Blyskal, 2009; López-Miras et al., 2013; Pinzari et al., 2010; Santos et al., 2009; Sterflinger, 2010).

Parchment, semi-solid collagen matrix produced from animal skin (*i.e.*, sheep or goats), is a significant part of the CH, being used as writing material since ancient times. Because of their animal origin, the parchments easily undergo bio-deterioration. Purple spots are the most frequent microbial alterations of ancient parchments (Migliore et al., 2017; Piñar et al., 2015): isolated or coalescent purple spots with a nucleated peripheral halo. Within the spots the damage of the collagen structure often leads to surface layer detachment at the written flesh side, resulting in the loss of historical content (Gallo and Strzelczyk, 1971; Migliore et al., 2016).

A broad spectrum of chemical treatments has been utilized to kill the organisms attacking library objects in an attempt to inhibit degradation (Adamo et al., 2004) but some of these (as the ethylene oxide fumigation) are extremely toxic and banned in some countries (Brokerhof, 1989; EC/1048/2005; OSHA, 1984) even if they represent efficacious systems for mass treatment of deteriorated library materials.

Among non-chemical treatments, an important contribution to

\* Corresponding author.

E-mail address: [monia.vadrucci@enea.it](mailto:monia.vadrucci@enea.it) (M. Vadrucci).