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First Brazilian Successful Case of Consolidation by Ionizing Radiation of a Polychrome Wood Sculpture – Research and Application

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Consolidation by ionizing radiation is a powerful technique that could be the last change for severely degraded wood sculptures. Wooden sculptures are biodegradable, generally attacked by xylophagous insects, creating internal porosity and consequently weakening the structure. The consolidation process is based on the impregnation of a radiation curing resin by pressure into a porous object followed by irradiation treatment with gamma rays to induce polymerization and crosslinking of the impregnated polymer. However, the radiation curing resin formulation must be selected through preliminary tests to avoid volume expansion between other during the curing process. Irradiation parameters are restricted with respect to dose rate and total absorbed dose. In this work, several formulations of polyester resins, methyl methacrylate and styrene were studied under different gamma irradiation conditions, as well as absorbed dose and dose rate. A polychrome wooden sculpture from the Bandeirantes Palace Museum, Sao Paulo – Brazil was characterized by nondestructive tests such as X-rays and tomography and selected for application of the consolidation method with 50%/50% polyester-styrene resin. A special device tank build on stainless steel and valves was developed to perform the impregnation. The sculpture was placed and fixed inside the impregnation tank. A very low vacuum of about 10 mbar was applied to the system to introduce the radiation curing resin from the bottom to avoid air bubbles or voids. After the first impregnation stage, a positive pressure of around 5 bar was applied using nitrogen for approximately 24 hours in the closed system. Finally, the excess resin was removed and stored in a reservoir tank. The impregnated sculpture was irradiated using a dose rate of 1 kGy.h⁻¹ with a total absorbed dose of 40 kGy in the Multipurpose Gamma Radiation Facility at the Nuclear and Energy Research Institute – IPEN, Brazil. It was necessary to interrupt the irradiation with 2 kGy to remove excess resin from the surface of the sculpture at the gel transition point. After the consolidation process, the sculpture was characterized with non-destructive tests and restored.