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# Surface Coating and Study of Metallic Cores for Radioactive Sources Production Used in Cancer Treatment

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**Abstract.** Developing new and innovative treatments for cancer is an urgent matter. The National Institute of Cancer estimates that Brazil will have 576,000 new cases of the disease in 2015. Our research group is developing new radioactive seeds to be use in radiotherapy procedures since the early 2000's. We present the surface study and research for two of our major projects: iodine-125 seeds for prostate, brain and eye cancer treatment and iridium-192 for eyecancer treatment.

## Introduction

Brachytherapy is medical technique that uses a radioactive source placed close to or in contact with the target region.[1] The treatment is performed as temporary or permanent implants depending on the location and type of lesion.[1] The major advantage of this method is that the target receives the most of the radiation dose, protecting healthy surrounding tissues. [2]

The therapy with radioactive seeds is used mostly to treat malignant tumors. According to theWorld Health Organization (WHO), 2030 will present 21.4 million new cases, 13.2 million cancer deaths and 73 million people living with the disease. Currently, cancer is the second cause of death in most countries.[3] In Brazil, The National Cancer Institute estimates 576,000 new cases for 2015.[4]

There are several types and formats of radiation sources used for brachytherapy. For prostate and eyecancer 4.5 mm cylindrical radioactive seed is largely used (figure 1).[5] This seed consists in 3mm radioactive core that is encapsulate inside a titanium shell. Our research group in Brazil is currently investigating two configurations: a silver core with iodine-125 deposited onto the surface,[6] and an iridium-192/platinum alloy core.[7]

Developing a methodology for the deposition of radioactive iodine on the silver wire (core) and a nuclear activation process of the iridium are necessary in order to have an efficient, inexpensive and reliable products. [8]

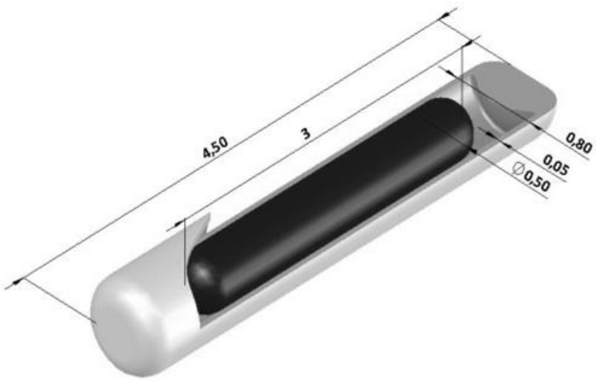


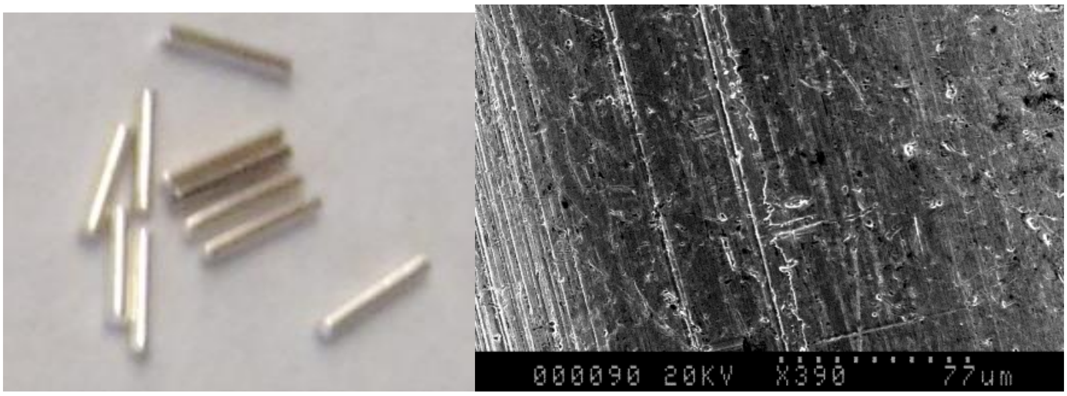

Figure 1. Seed scheme (dimensions in mm).

The goal of this paper is to compare how silver surface treatment can influence the radioactive iodine intake and to present our surface study and activation analysis on the iridium core.

## Methodology and Results

### Iodine-125

The silver wires were treated with a mixture of hydrogen peroxide sulfuric acid. The surface color changes from shiny metallic silver to a matte gray. Surface analysis were performed by SEM,Scanning Electron Microscopy. Figure 2 presents the untreated silver and Figure 3 the treated versions.




(a) (b)

Figure 2. a) Untreated silver b) SEM image. Note the grooves made by the manufacturing machinery.


(a) (b)

Figure 3. a) Treated silver b) SEM image.

The radioactive coating were performed with both untreated and treated silver. The cores are placed in a glass vial in batches of five, with a radioactive $Na^{125}I$ solution in pH 8. After 24 hours, the radioactive intake ($Actv._{end}$) is measured by a calibrated ionization chamber and calculated according to Eq. (1). Results are presented in Table 1.

$$\%_{\text{yield}} = \frac{\text{Actv}._{\text{end}}}{\text{Actv}._{\text{beginning}}} * 100 \tag{1}$$

Table 1. Average $\%_{yield}$ for all radioactive fixation.

| Method | Average $\%_{yield}$ |
|---|---|
| Untreated Silver | 0% |
| Silver treated | 72% |

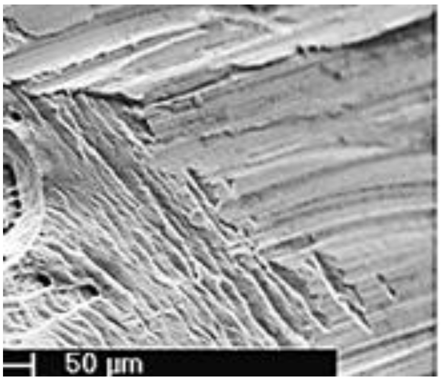
## Iridium-192

A sample of the iridium/platinum core was ruptured by emerging in liquid nitrogen. The posteriorSEM analysis (fig. 4a) confirmed the desired percentages of 25% for iridium and 75% for platinum. The 25% iridium percentage is ideal to result in the correct activity for eye cancer treatment.

The 3mm cores were placed in a device developed for the nuclear reactor activation (fig. 4b). This device were made of aluminum and attached together by and aluminum foil. Extra care were taken by positioning the device in the nuclear reactor in order to activate the maximum amount of iridium in all samples.

Both platinum (30 minutes) and aluminum (15 hours) have a fast radioactive half-life when compared to iridium-192 (73.83 days) which allows the device to be securely open in 7 days.

All the nuclei had their activity quantified by an calibrated ionization chamber. They had an 11.4% deviation when compared to the average, consider an excellent result.




(a)

(b)

Figure 4.a) SEM image of the ruptured platinum/iridium nuclei b) Irradiation aluminum device.

## Discussion and Conclusion

Our research group is currently developing two sources that can be used for cancers treatment: a silver core coated with iodine-125, and another with iridium-192 in a platinum/iridium core.

For the iodine-125, analysis were performed with the silver nuclei. SEM images of the untreated silver showed practically smooth surface area that result in no radioactive intake. The treated nuclei presented a pitted surface that yielded in 72% iodine-125 coating.

The platinum/iridium core was usefully nuclear activated generating iridium-192. Activity deviation was excellent. The iridium quantities in the sample is ideal for treatment. SEM image presents an even alloy.

We hope to produce and made the seeds available for both public and private hospitals by 2017.

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