Radioactive Ion Implanter for Medical Applications within the RadBioMat–Project ◇

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The aim of the RadBioMat–Project (Radioactive Bio–compatible Materials) is the development, production and application of new materials for use as radioactive implants in brachytherapy, especially for benign diseases. As reported last year [1] one subproject is located at the accelerator laboratory of the MLL and covers design and construction of a radioactive ion implanter. In December 2004 we demonstrated the first (stable) ion beam with this implanter.

1. Low Emittance Sputter Source

Opposite to implantation into metals, radiation sensitivity is a major concern for organic materials. Unnecessarily high ion doses could influence the surface of the implant materials in an unfavorable way especially in case of biodegradable materials. Thus we had to choose a type of ion source which avoids molecular beams, in particular ^{31}PH formation, and moreover the partition of ^{32}P ions into different charge states. Based on the experience acquired over many years at our accelerator laboratory a negative ion sputter source has been designed and built which uses an Al sputter target with an AlP insert.

Furthermore the source needs to have a low emittance as the beam will be focused down below one millimeter to activate even small implants. Therefore we optimized the area of the sputter spot below one millimeter by using a new designed spherical Cs-Ionizer. Emittance measurements on a test bench showed an emittance below 30 π mm mrad at 30 keV. The next steps are tests of the long-time behavior of the source and ion emittance measurements at 180 keV in the new ion implanter.

2. Radioactive Ion Implanter

The construction of the radioactive ion implanter follows ideas developed at the Research Center Karlsruhe (FZK) where an implanter with mass separation for 60 keV ^{32}P ions had been installed for production of radioactive coronary stents [2].

The implanted ^{32}P should remain in the implant materials as long as possible and wash out minimized, therefore we decided to increase the implantation energy to 180 keV which shifts the mean implantation depth of ^{32}P ions from 130 to 350 nm. As our existing mass separation magnet has sufficient bending power, the ions can be accelerated before the magnet which improves the ion optic and mass separation as well.

The energy supplied for the high voltage platform is achieved by a new technique. Instead of using a high voltage isolating transformer, which is known to be expensive and limited in lifetime, we use a setup consisting of a regular electric motor and a synchronous generator. They are coupled by a non-conducting toothed belt. The high voltage platform houses also the fore-pump of the ion source to avoid unnecessary vibration at the source platform. The ion implanter is completely assembled as shown in Fig. 1 including the diagnostic elements at the first focus behind the separation magnet and around 1 μA Cu ions at 180 keV energy was demonstrated using a Cu sputter target.

Now a fully remote controlled operation system has to be developed as well as a safety system for high voltage handling. The vacuum system has to be extended to a production chamber with a special focusing system in front.

References

[1] W. Assmann *et al.*, Annual report 2003, p. 67-68
[2] E. Huttel *et al.*, Rev. Sci. Instrum. **73** (2002) 825

Fig. 1: Photograph of the radioactive implanter taken beginning of January 2005.

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