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## A novel treatment approach after glioblastoma resection: microcontroller-based surgical implant with light-emitting diods for postoperative irradiation of glioblastoma cells

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Glioblastoma is the most common and most aggressive primary brain tumor in adults. The world health organisation (WHO) classified this quickly growing, malignant tumor as grade IV, i.e., the highest grade. The annual incidence of glioblastoma is 3 per 100,000 inhabitants. In 2016, there have been an estimated 12,120 new cases. Even with intensive treatment of glioblastoma consisting of so-called maximum safe resection followed by radiotherapy and chemotherapy, the disease routinely remains incurable and displays tumor recurrence and/or progression. Even after maximum available multimodal treatment, the median survival of patients with glioblastoma is only 14.6 months. Therefore, new therapeutic options are urgently needed. One such option is photodynamic therapy (PDT) which employs a photosensitizer that is taken up and selectively metabolized by tumor cells, then activated by light of specific wavelength to become cytotoxic. In experimental clinical settings, different PDT methodologies have already shown promising results. For the treatment of glioblastoma, intraoperative PDT, which uses high light intensities within a short period of time after tumor resection, has been explored. A novel approach has been developed at Ulm University of Applied Sciences in cooperation with Ulm University Hospital (Department of Neurosurgery). An implant for repetitive PDT (rPDT) is placed into the tumor resection cavity for long-time use. As a result, lower light intensities can be applied for longer time intervals to further reduce the residual tumor cells and minimize the adverse prognostic factor of tumor recurrence and/or progression. In vitro tests did not show any kind of resistance of glioblastoma cells towards the phototoxic effects exerted by the PDT even after repetitive treatments. In addition, an alternating treatment consisting of PDT and radiation with UV-light enhances the cytotoxic effects in vitro. A first implant prototype using LEDs for PDT and UV-light has been tested successfully in vitro and will be further evaluated in a preclinical in vivo model.

# V 132

## Low energy electron beam sterilization for novel interactive implants and their components

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Within the field of organ and patient support systems, research on novel interactive implants with integrated electronics composed of sensible materials and biological active substrates increased tremendous during the last years. Prior to implantation, these products and devices have to be sterilized. Tradtionional sterilization techniques like ethylene oxide or steam have their drawbacks when utilized for sensitive organic or metallic materials in sensors, microchips etc. Also, the use of gamma irradiation for such products is problematic due to long exposure time under radical atmosphere, which leads to an increased degradation and therefore can result in a loss of functionality.
Using low energy electron irradiation, it is possible to sterilize medical surfaces within some seconds because of very high dose rates. Thus, degradation processes which are occurring during the duration of gamma sterilization can be minimized using ultrafast electron beam sterilization. In addition, it is possible to define the penetration depth of the electrons in order to prevent electronic parts from damage. Besides sterilization of polymers and electronic components, it is possible to use low energy electron beam irradiation for sterilization of diverse biological materials like peptides, collagen matrices, transplantation tissues or hydrogels. Furthermore, specific material modifications can be addressed within these applications.
The process of irradiation sterilization is accepted all over the world and complies with international standards (ISO 11137). The aim of the development work at Fraunhofer FEP is to adapt the low energy electron beam process for new applications and products, but also to develop in-line-capable systems for sterilization applications in production processes and on-site batch systems. An overview of numerous sensitive components for interactive medical implants and products showing the potentials and limitations of low energy electron beam sterilization will be presented.

# V 133

## Development of a controlled-occluding membrane as a stent graft component for spinal cord ischaemia prophylaxis

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Thoracic and thoracoabdominal aortic aneurysms (TAAA) are complex and life-threatening diseases. The open aneurysm repair is a surgical intervention potentially associated with high morbidity and mortality. The process-associated risks and complications have been reduced by the implementation of the endovascular approach. However, the risk of spinal cord ischaemia leading to paraplegia is an unsolved problem of TAAA repair. For the complex and unpredictable supply of blood to the spinal cord by intercostal and lumbar collateral arteries, there is as yet no adequate solution in the area of endovascular stent grafts.
The aim of the scientific investigations is the development of a textile hydrogel composite membrane which occludes as a functional unit of a stent graft in a controlled time interval, which is necessary for the formation of collateral spinal cord supply. Thus the balancing act between safe endovascular aneurysm repair and the previously unresolved problem of protection against spinal ischemia can be ensured.
The occluding membrane consists of a textile hydrogel composite membrane. The mechanical properties, as well as the pore size and the pore size distribution are determined by the targeted design of the warp knitted textile structure. The hydrogel system is developed according to the required occlusion period. Finally, the textile mesh structure will be sheathed with the hydrogel and incorporated into the stent graft. Triggered by components of human blood, the hydrogel swells under controlled conditions and ultimately seals the membrane.
In this presentation the development of the textile hydrogel compostite membrane as a functional unit of a stent graft will be described. This part is devided into the development of the hydrogel system and the textile structure as well as the sheathing process. Subsequently, the most important results (occlusion period, permeability, mechanical properties, etc.) are described and discussed.