crossing-linked by genipin were hardened on the superhydrophobic surfaces. Upon plasma treatment, cell attachment onto the beads surface was improved as compared to the untreated ones. The chitosan beads could move throughout the liquid medium by the action of an external magnetic field. After extracting the particles from the medium the cells could be detached from such supports by the action of trypsin and the particle could be used again. The extracted cells were found to maintain their viability. In conclusion, magnetic responsive hydrogel beads could be prepared by using superhydrophobic substrates

P26 (EI0303)
HR-MAS NMR SPECTROSCOPY AS EFFICIENT TOOL TO CHARACTERIZE CROSSLINKED HYDROGELS
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Objectives: In the present work, high-resolution magic angle spinning (hr-MAS) NMR spectroscopy is applied as a straightforward non-destructive technique to quantify unreacted methacrylamide functionalities in cross-linked gelatin hydrogels.
Methods: 10 w/v% cross-linked methacrylamide-modified gelatin (gel-MOD) hydrogel films were prepared and lyophilised, followed by resuspension in D_2O. The effect of the photo-initiator concentration (Irgacure 2959, 0.5–10 mol%) and the applied UV irradiation time (5–30 minutes) on the consumption of methacrylamide moieties was evaluated using hr-MAS NMR spectroscopy.
Results: The results (data not shown) indicate that a critical amount of 2 mol% photo-initiator is required to obtain a significant amount of methacrylamide-crosslinking. Upon increasing either the photo-initiator concentration (2–10 mol%) or the UV irradiation time (5–60 min), the percentage of reacted methacrylamides increased significantly ($P<0.05$). Interestingly, it can be observed that even at a UV irradiation time of 1 hour and a photo-initiator concentration of 10 mol%, only 40% of the methacrylamide side groups have reacted. In a final part of this work, rheological measurements were performed to correlate the mechanical properties of the hydrogels developed with the cross-link efficiency obtained from hrMAS NMR. Increasing either the photo-initiator concentration or the UV irradiation time, leads to an increased storage modulus. In addition, the mechanical data indicated that both the storage and loss moduli display a pronounced plateau value in the frequency region studied. Moreover, G' is about two orders of magnitude higher than G", which is indicative for the formation of a well-established network.
Conclusions: We can conclude that hr-MAS NMR spectroscopy is a suitable, non-destructive and straightforward tool to evaluate absolute hydrogel cross-linking efficiencies. Although the technique was only applied for gelatin-based hydrogels, we are at present investigating the applicability to other hydrogels including vinyl functionalised Pluronic-based systems.

P27 (EI0205)
ENHANCED FUNCTION AND ADHESION MECHANISM OF HUMAN BONE MARROW CELLS ON FUNCTIONALIZED CARBON NANOTUBES
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Objectives: Carbon nanotubes (CNTs) have attracted much attention as a biomaterial with interesting potential applications. The disadvantage of insolubility has been overcome by functionalization of CNTs surface. In this study, human bone marrow stromal cell (HBMSC) adhesion, proliferation, and differentiation, cultured on multi-walled CNTs, either pristine or amino-, carboxy- and hydroxy-functionalized, were investigated. Preliminary results on integrin-mediated adhesion mechanisms were also obtained.
Methods: Functionalized CNTs were synthesized according to well-established methods and were fully characterized with TGA and Raman analysis. The HBMSCs were routinely cultured in human osteogenic medium. Cells of second to forth passage were seeded on the materials. Morphology and adhesion were evaluated by SEM after 1 and 3 days, proliferation was estimated by DAPI staining after 3 and 7 days and differentiation through alkaline phosphatase activity (ALP). To screen which integrins were responsible for attachment of the cells, monoclonal antibodies against integrin subunit β_1 were incubated with the cells for 30 min at 37° C, prior to seeding on the CNTs surfaces.
Results: SEM images display that HBMSCs attach and spread well on all CNTs surfaces without differences in their morphology. Proliferation was highest on amino-functionalized CNTs, but not significantly different from the other surfaces. However, proliferation on the control (tissue culture plastic) was 3-fold. The highest expression of ALP activity was on hydroxy-functionalized CNTs and the lowest on pristine. After 3 days of culture, the ALP expression on CNT surfaces was approximately 70% of the control, whereas after 7 days, it was 4-fold of the control. The blocking of integrin subunit β_1 with monoclonal antibodies resulted in a decrease of the adhesion percentage to pristine CNTs at 40-50%.
Conclusions: It is possible that nanomaterials, whose structural features resemble those of natural tissue, enhance cell function and CNTs can be used as orthopaedic biomaterials.

P28 (EI0124)
PHYSICAL CROSSLINKING OF GELATIN: A SUPRAMOLECULAR APPROACH TO BIOMATERIAL
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Objectives: Key properties that a biomaterial should address include elastic properties close to the substituted tissue, specific adhesion epitopes, and tailorable degradability. A knowledge-based approach formed the basis for investigating the systematic variation of material properties of gelatin by introducing functional groups derived from tyrosine for enabling π-π interactions as well as hydrogen bonds to form stable physically crosslinked networks.
Methods: Gelatin was functionalized with desaminotyrosine (DAT) or Desaminotyrosyl-tyrosine, (DATT). Atomistic molecular models of pure and functionalized gelatin with 0.8wt.-% or 25wt.-% water content were constructed using Material Studio (Accelrys) and submitted to the Amorphous Cell module to create bulk packing systems. The dynamic behaviour, structural, and mechanical properties were investigated by analyzing free volume distribution, solubility parameters, elastic properties, and aggregation phenomena. The functionalized gelatins were synthesized by coupling of the free carboxylic acid groups of DAT(T) to the amino groups of gelatin and the materials were characterized by tensile tests, TM-DSC, swelling experiments, and WAXS.
Results: The simulations predicted an increasing number of aromatic functions attached to the gelatin chain leading to an increase in the number of physical net-points. In the synthesis, about 80mol.-% of all amino groups were functionalized with DAT(T). Increasing the number of aromatic groups attached to the gelatin chain resulted in suppression of helix formation and decreased the swelling degree. Mechanical properties (Young's modulus, elongation at break, and maximum tensile strength) of the gels at equilibrium swelling increased with the number of introduced aromatic groups.
Conclusions: Distinct tailoring of material properties was achieved for a biopolymer by only small changes in molecular structure of gelatin. The approach of molecular modelling of gelatin as bulk material permits to analyze structural features of functionalized materials and can be used as predictive tool in the design of new biopolymer-based materials.

P29 (EI0336)
TEMPERATURE-RESPONSIVE MICROCAPSULES PREPARED BY NANOSTRUCTURED MULTILAYERS OF CHITOSAN AND AN ELASTIN-LIKE RECOMBINAMER FOR THE CONTROLLED RELEASE OF THERAPEUTIC MOLECULES
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Objectives: Polyelectrolyte vesicles using layer-by-layer (LbL) were recently introduced for the encapsulation of therapeutic molecules. This work presents multilayered microcapsules of chitosan and a temperature-responsive elastin-like recombinamer (ELR) as a novel drug delivery system. The release of a pre-loaded model protein was studied at distinct temperatures and number of layers to evaluate the permeability of these structures and their potential as tunable drug delivery devices.
Methods: Sacrificial $CaCO_3$ microparticles were prepared by co-precipitation of Na_2CO_3 and $CaCl_2$ in a FITC-BSA solution under heavy stirring. LbL coating was performed by incubation with chitosan or ELR solutions, with a rinsing step in between. Capsules with 1, 3 and 5 bilayers were made. The $CaCO_3$ cores were chelated using EDTA. The capsules were suspended in PBS at 25 and 37°C and samples were taken every 24 hours for fluorescence measurements, during 14 days.

Results: At both temperatures, cumulative release was higher for capsules with 1 bilayer, evidencing the role played by the capsules architecture in their permeability. The release kinetics among each temperature was also different: the BSA quantity released was higher at 25°C than at 37°C. Considering the case of a simple bilayer, in the former the cumulative release reaches 80%, while in the latter only 50% of the encapsulated protein is released. This result shows the effect of temperature in polyelectrolyte structures, namely when temperature-responsive materials like ELRs are used.
Conclusions: Multilayered microcapsules based on chitosan and an ELR were studied as drug delivery vessels. Distinct release profiles of pre-loaded BSA at different temperatures and layer numbers demonstrated the influence of the capsules architecture and composition: more quantity of BSA is released for capsules with fewer layers and lower temperatures. These microcapsules have the potential for tunable drug release in tissue engineering applications by means of design changes.

Engineering for Cardiac Assist Devices

P30 (EI0380)
CFD ANALYSIS OF THE BLOOD FLOW IN A HOLLOW FIBER MEMBRANE OXYGENATOR WITH MULTIPLE PASSAGEWAYS
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Objectives: This work presents a 3D computational fluid dynamics (CFD) approach for modelling blood flow in a state-of-the-art hollow fiber membrane oxygenator with integrated heat exchanger. During extra-corporeal circulation blood needs to be heated and oxygenated before being reinfused into the patient. Optimal gas exchange and minimal pressure drops are two basic requirements in the design of membrane oxygenators. In the present study, the effects of multiple passageways to enhance blood oxygenation within the device were assessed through a CFD analysis.
Methods: The fluid volume inside the device was discretized with about 2.5 million elements. Blood was modeled as an incompressible Newtonian fluid with viscosity μ=3.0 mPa·s and density ρ= 1060 kg/m^3. A blood flow of 4 L/min at the inlet section gave rise to non-laminar inflow conditions (Re=2880). Hence, the viscous k-ω two-equations turbulence model with low Reynolds number corrections was adopted. The heat exchanger and oxygenator regions were modeled as porous media with permeability values obtained from experimental tests. Laminar flow regime was assumed in those regions. CFD simulations were performed using the commercial software ANSYS FLUENT®.
Results: Computational results were post-processed to extract the flow velocity pattern, the potential stagnation areas and the pressure drops. The shape of the oxygenator ensured a good intermixing of flow thanks to the multiple passages of blood inside the fiber bundle. The overall pressure drop was equal to 200 mmHg. High local pressure gradients, originating from high-flow concentrations in collecting and distributing regions, were detected.
Conclusions: The CFD-aided analysis allowed evaluating advantages and drawbacks of the device geometry. The tortuous pattern of blood inside the oxygenator may be an effective strategy to enhance mass and heat transfer within the device, by allowing a multiple blood crossflow within the fibre bundle at low velocities and limiting the pressure drops.

P31 (EI0252)
TRANSCUTANEOUS ENERGY TRANSFER SYSTEM (TET): *IN VITRO* AND *IN VIVO* VALIDATION
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Objectives: Percutaneous drivelines cause infections and technical problems. To minimize complications and increase patient's mobility, a transcutaneous energy and data transfer system is to be developed with high tolerance of transmission and a convenient external carrier system.
Methods: The inductive TET includes two coreless coils (D=60mm) with external and internal control units equipped with accumulators. An integrated controller provides telemetry data processing and control of the implant. Wireless data transfer is enabled by using RF transmission and a proprietary protocol. The performance is verified in a body simulator *in vitro* and in acute animal studies (pigs, n=4). A positioning assistance is developed for exact placement of the external coil. A carrier system for the external components is designed as a flat textile backpack in which the external transmitter coil is integrated. The carrier system is verified in a study with VAD patients.
Results: The developed TET is able to transmit up to approx. 25 Watt through the tissue. Bi-directional data communication is improved to a rate of 500 kbits/sec, were the external receiver is allowed to be up to 3m distant to the patient. The maximum efficiency of the system is approx. 83% at 15mm distance between the coils and 79% at 25mm distance. Displacement of the coils up to 20mm reduces the efficiency up to 15% and leads to a warming of the external transmitter electronic. No warming is measured between the coils and the implanted components under any operating condition. The positioning system enables easy alignment of the external coil with an accuracy of 1.6mm.
Conclusions: The TET shows reliable transmission at horizontal and vertical displacements up to 35mm. Transmitted energy is automatically adapted to the demand of the implanted device. Twisting of the flexible coils did not influence the transmission appreciably.

P32 (EI0167)
DEVELOPMENT OF A PORTABLE PNEUMATIC DRIVER FOR THE WHOLE RANGE OF BERLIN HEART EXCOR BLOOD PUMPS
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Objectives: Paracorporeal, pneumatically driven VADs are preferably used for biventricular adult support as well as for pediatric patients. For the EXCOR® System (Berlin Heart GmbH, Germany), a new pneumatic driver that combines the performance and versatility of the existing stationary driver with the flexibility of the existing mobile driver is currently under development.
Methods: The new driver uses the reliable and proven pneumatics technology of the EXCOR mobile driver. Two piston pumps operate in synchronism with the blood pumps. The piston of each pump is driven by an electric motor via a ball-screw. A closed pneumatic system was chosen to optimize the system efficiency. A control system regulates the pneumatic pressure and blood flow waveform, emulates the Frank-Starling behavior, synchronizes both blood pumps and ensures optimal adjustment of the enclosed air mass. An emergency mode of operation is provided by a fault-tolerant embedded computing system in combination with a dedicated crossover valve without unduly increasing the system complexity and weight. Special attention has been paid to easy handling and a clear alarm and message structure. The driver is mounted on a cart and is equipped with two easily exchangeable batteries, a mains power adapter and a car power adapter.
Results: At 8kg the new driver is lighter than the EXCOR mobile driver. It supports blood pumps in the range of 10mL to 80mL. The power consumption for biventricular adult support is 20W and less for pediatric support. The batteries guarantee cordless operation for at least 8 hours. Bench tests have demonstrated correct performance with respect to preload sensitivity and flow profile.
Conclusions: The new pneumatic driver is able to drive all sizes of EXCOR blood pumps. Its small dimensions, low weight and new design make it suitable for stationary as well as portable use.

P33 (EI0148)
THE CONTINUOUS FLOW LVAD WITH NATIVE HEART LOAD CONTROL SYSTEM (NHLCS) FOR BRIDGE TO RECOVERY COULD CONTROL THE CORONARY FLOW AND MYOCARDIAL OXYGEN CONSUMPTION IN ACUTE HEART FAILURE MODEL
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Objectives: A novel control system for continuous flow LVAD has been developed for bridge to recovery. We have reported that the amount of coronary flow and myocardial oxygen consumption (MVO2) could be controlled by changing its rotation speed in synchronization with the native cardiac cycle, in normal heart models. We will confirm whether the coronary flow and MVO2 can be controlled by the NHLCS under acute heart failure conditions.
Methods: Ten adult goats (61.4±12.6 kg) with acute LV dysfunction due to coronary microsphere embolization (50μm, 0.42±0.22million) to left Anterior descending artery were used for the experiment. The continuous flow LVAD