Society of Plastics Engineers • Upper Midwest Section

October 2014 • *Volume 41*

THE SPECIALIST

MEGATEC 2014

TUESDAY, NOVEMBER 11, 2014

CENTURY COLLEGE - 3300 Century Avenue N., White Bear Lake, MN 55110

3D Printing - From Evolution to Revolution

A one day conference where 8 presentations from the industry will discuss the latest developments in the area of 3D Printing.

Now is your opportunity to get hands on exposure to local and national presenters regarding the fastest growing manufacturing trend in the world! The content will take you across different industries and different applications. You will see the latest trends in materials, processes and technologies.

SCHEDULE OF EVENTS: **9:00 am - 9:30 am** Registration & continental Breakfast, **9:30 am - 4:30 pm** Tabletop Exhibition, **9:30 am - 4:00** pm All Day MegaTec (Lunch and Breaks included), **4:30 pm - 6 pm** Reception/Networking and Optional Tour of Century College Fab Lab.

MORNING SESSIONS

KEYNOTE: ***The Evolution of 3D Printing and Where it Came From*** -
Scott Crump - Founder of Stratasys

3D Printing: Another Tool in the Toolbox for Students going into manufacturing -
Scott Simenson - Century College

3D Printing as R&D in the Universities - Dr. Art Erdmann - University of Minnesota

Manufacturing the Future: Products and Materials Offered by 3D Systems - Greg Elfering - 3D Systems

Sustainable 3D Printing Materials - Dan Sawyer - Natureworks

AFTERNOON SESSIONS CONTINUED ON PAGE 2

REGISTER TO ATTEND:

Before November 5th, SPE and PDMA Members - $80.00 and Non-Members $100.00.
After November 5th, SPE and PDMA Members - $125.00 and Non-Members $125.00.

INFORMATION AND ONLINE REGISTRATION:

General Information; Matt Havekost, Phone: 952-484-7436
Payment Information; Rolly Enderes, Phone: 715-726-2300 or Email: rolly@chemceed.com
Registration Site; **http://www.uppermidwestspe.org/events.htm**

MEGATEC 2014 3D Printing - From Evolution to Revolution

AFTERNOON SESSIONS

AFTERNOON KEYNOTE: ***3D Printing in Hollywood*** - Jason Lopes - Legacy Effects

3D Printing of Today and Tomorrow: Products and Materials Offered by Stratasys - Susan York - Stratasys Materials and Technologies

3D Printing in Big Box Retail - Stacy Abel - Target Corporation

Product Development and 3D Printing - Paul Pilosi - White Board

Q & A Discussion

ABOUT THE SPEAKERS

S. SCOTT CRUMP - is the inventor of fused deposition modeling (FDM) and co-founder of Stratasys, Ltd. Crump invented and patented FDM technology in 1989 with his wife and Stratasys co-founder Lisa Crump. He is currently the Chairman of the Board of Directors of Stratasys, which produces additive manufacturing machines for direct digital manufacturing (a.k.a. rapid manufacturing); these machines are popularly called “3D printers”. He took the manufacturing company public in 1994 (Nasdaq: SSYS). He also runs Fortus, RedEye on Demand, and Dimension Printing - business units of Stratasys.

JASON LOPES - is lead systems engineer at Legacy Effects, a practical effects studio that has combined 3D printing with traditional sculpting, prosthetic make-up, and mold-making to create indelible monsters, armored suits, anthropomorphic animals and intricate robots for today’s biggest movies (Avatar, RoboCop, The Muppets, Iron Man, etc.). They also use 3D printing technology to augment entirely digital characters with lighting and reference models as well as custom 3D-printed tools and molds. Not only are they ahead of the Hollywood additive manufacturing curve, but they’ve been utilizing the technology since the early 2000s. Legacy’s systems engineer Jason Lopes is an industry specialist who will take you inside the processes, workflows and real-world solutions that are allowing Hollywood studios to create better-looking movies in less time with an improbable combination of advance precision and increased flexibility.

President's Remarks *Shilpa Manjure*

Greetings again to all of you! Hope everyone had a great summer and enjoyed the pleasant weather we have had this year.

SPE Upper Midwest section had two events this summer – a golf outing and a plant tour to Tennant Company. Both of these were a great success and thanks are due to two of our Chairs – Eric Swensied and Matt Havekost – for taking the time and dedicated effort in organizing them. A summary and pictures from these events have been included ahead in this newsletter.

I would like to specially note that in a world where businesses do not work much without confidentiality agreements and don't open doors for tours, what a fantastic job the team at Tennant did at the plant tour. Tennant not only volunteered to show what rotomolding and structural web molding was about, they also educated the local SPE community by sharing their experience in what it takes to design, build and process a new part. It is the first time we combined a presentation with the tour itself and it was well received with active participation from all attendees.

Both these events were in line with our goal to offer education and variety of networking opportunities for plastics professionals. If you are a plastic vendor, processor, or convertor it is a great time to establish that personal connection with your existing customers and suppliers or new ones without traveling much as we are right in your area. If you have missed the first two events, I would highly encourage you to take the opportunity to attend and participate in our upcoming MEGATEC event this November. The topic is "3D Printing – From Evolution to Revolution". 3D Printing has been a hot topic in several plastic applications and prototyping conferences and you wouldn't want to miss the chance!!

The Board is planning on conducting a brief survey this Fall to asses other topics of interest to the membership. Please take a few minutes to respond to this survey so we can do a better job of catering to your taste and needs.

Lastly, if you are still looking for a way to get involved and help out or are completely new to SPE, I would urge you to attend one of the many events scheduled. Our event chairs are looking for enthusiastic volunteers and we are also looking for creative individuals to help with our membership efforts as well as serve in leadership positions within the Chapter.

On a personal note I would like to express gratitude to all the current Board members and committee Chairs. In my first quarter, I have gotten to admire the leadership and commitment of this group and feel very fortunate to be a part of a team that is cohesive and passionate for the work they do!

As always looking forward to meeting you at our next event – THE MEGATEC! Do make sure you register sooner than later to reserve your spot as seats are limited!

Sincerely,
Shilpa

Spotlight on the board

SEAN MERTES - Sales Manager Midwest - PTS, LLC

When asked to write a brief bio for the "Spotlight on the Board" section of The SPEcialist, I reacquainted myself to previous newsletters. During this process, I realized from reviewing a September 2006 issue that I was the program chair during that time for the topic of "Innovative Thermoplastics Elastomers". The last event I was responsible for was in 2010 for a full day technical conference "Selecting the Proper Plastics Material". As I think back, I believe I was the SPE Program Chair from 2000 to 2010. The years have gone by and it's great to be back in a prominent role again with the local SPE chapter serving as Co-Program Chair. History has proven that this group coordinates outstanding technical presentations year over year. Supporting your local SPE chapter by becoming a member and attending seminar topics and conferences is the perfect way to remain engaged in this industry.

Born on a farm in South Dakota, I decided to go to school for Mechanical Engineering and graduated from South Dakota State University with a MS in the program. I began my professional career by working at Falcon Plastics in Brookings, SD as a Plastics Project Engineer. I later accepted a Technical Representative position with General Polymers (later known as Ashland and currently Nexeo) to cover the Minnesota territory. After fourteen years in that role, I advanced to the position of Application Development Engineering for corporate accounts throughout the U.S. In August of 2013 I joined Polymer Technology and Services, LLS (PTS) as Sales Manager for the Midwest Region. PTS is a manufacturer of high quality, UL listed thermoplastics and supplier of name brand and generic engineering resins. Our global footprint includes United States, Canada, Mexico, China and the U.K.
I look forward to returning to the board and seeing you at future technical programs!

WELCOME TO OUR NEW MEMBERS

We are pleased to welcome our newest members of the Upper Midwest Section. As of August 31st, our section has 352 active members! Tell your friends and co-workers about the SPE Upper Midwest Section to help us grow and check out our website, www.uppermidwestspe.org, and the national website, www.4spe.org, to know all that SPE and this section has to offer

New Member	Affiliation
Mason Rohde	
Katrina Moore	
Shane Fischer	Kraidburg Type Corp.
Michael Annan	Northern Technologies Int'l Corp.
Yourri-Samuel Dessureau	IT
Lukas Duddleston	University of Wisconsin Madison

SPE Education Committee

Paul Rothweiler and Tom McNamara

Your Upper Midwest Section has scholarships available for students that have an interest in pursuing a career in the plastics industry. We have three levels of scholarships to include students attending colleges for certificate / AAS, BS, and graduate studies in plastics. Applications are being taken now for students who meet the requirements. Awards will be made at our November 11 MegaTec. Descriptions and applications for the scholarships can be found on the Upper Midwest Section website: **www.uppermidwestspe.org.**

TENNANT PLANT TOUR RECAP *By Matt Havekost.*

Innovative Plastics Design and Manufacturing Methods

The SPE- Upper Midwest Section sponsored a Factory Tour at the Tennant Company on September 11th, 2014. Of course, Tennant was a superb host and went far and above a basic factory tour, presenting on three interesting topics related to their innovation in developing, testing and manufacturing of their plastic components for their T12 and T17 battery powered rider floor scrubbers.

Peter Loring, Tennant Fabrication launch Engineer, started things off with a presentation on their use of 3D printing in non-traditional applications to speed up functional testing in concept stages of development. He described an innovative method of 3D printing thin walled, single use molds that are used to mold flexible urethane materials into complex squeegee designs. The one time use molds are designed with 3D printing in mind and can literally be torn away from the urethane to reveal functional parts that can be tested in days rather than weeks or months.

Koda Sanborn, Tennant Fabrication Manufacturing Engineer, was up next with a very interesting presentation around Tennant's internal rotational molding capabilities that have been added in Golden Valley to support a larger operation in Holland, MI. Koda offered information about what was involved in the site preparation for the massive equipment, how the equipment was selected, as well as some unique ways in which Tennant utilizes technology to reduce the "black art" traditionally involved in Rotational molding.

The third and final presentation was given by Brett Scott, Tennant Project Engineer, Interim Program Manager, in cooperation with Mike Duppong and Ryan Eckholm from EPC Molding (http://www.epcmolding.com/). Brett offered a tremendous insight into what it takes to go through the process of selecting a manufacturing process and managing the design for manufacturability, internal and external expectations, materials, etc. Three of the key components for the "operator station" on the floor scrubbers were highlighted to illustrate the process of selecting the best manufacturing method. Using these three examples, Mike and Ryan covered the basics of "multi nozzle structural web" molding in comparison to traditional molding methods.

Finally, we were lucky enough to be given a tour of the manufacturing plant where each of these presentation topics is put into practice. The tour included stops at the impressive rotational molding cell along with a view of the assembly line for the T17 scrubbers (see photos).

We are extremely thankful to Tennant and all involved to allow for this event to happen. They were tremendous hosts and made this event valuable to those who attended. In order to continue these types of event we need your support and participation! Please plan on joining us for upcoming local SPE events including our upcoming MegaTech on November 11th.

Brett Scott, Mike Duppong, and Ryan Eckholm presenting on "multi nozzle structural web" molding

Koda Sanborn explains technology to enhance capabilities and control in the rotational molding process

Tennant Tour of their new Rotational Molding Cell

Brett Scott demonstates the critical example parts from the presentation on the assembly floor

DEVELOPMENT OF AN ABSORBABLE MAGNESIUM-POLYMER FUSION CAGE FOR THE CERVICAL SPINE

Christian Hopmann, Theresa Kauth, Daniel Kaltbeitzel, Institute of Plastics Processing at RWTH Aachen University (IKV), Aachen, Germany
Dorothea Daentzer, Orthopedic Department of Hannover Medical School, Hannover, Germany Bastian Welke, Christof Hurschler, Laboratory for Biomechanics and Biomaterials of Hannover Medical School, Hannover, Germany
Bernd Kujat, Institute of Materials Science of Leibniz University Hannover, Garbsen, Germany

Abstract

Conventional fusion devices ("cages") are often used to join two vertebrae of the human spine and generally remain in the body for a lifetime and can theoretically lead to any complications. Therefore, an absorbable hybrid fusion cage consisting of a magnesium skeleton infiltrated with absorbable polymer (poly-ε-caprolactone, PCL) has been developed. The primary objective of the cage is to ensure an adequate stiffness of the disc space directly after the operation and to encourage the ingrowth of new bone tissue to secure longlife stability. Once a sufficiently rigid bone connection is formed, the implant should be absorbed. Within this paper results of in vitro investigations of the mechanical properties and of in vivo investigation in blackcap sheep are presented.

Introduction

Indications to perform a fusion procedure of the human cervical spine are degenerative disc disease, spinal canal stenosis and segmental instability. Necessary surgical steps are the removal of the intervertebral disc with adequate decompression of the neural structures and the replacement of the disc with an appropriate implant. Several fusion devices are available which act as a spacer to restore the intervertebral height and to maintain the results of the decompression of the functional spinal unit [1]. Otherwise, abnormal posture and again narrowing of the spinal canal with compression of the neural structures could occur. This could lead to neurological disorders up to severe motor and sensory deficits. Several types of intervertebral spacers are used hitherto. The golden standard is to use an autogenous bone graft coming from the iliac crest which shows the best biocompatibility and fusion rate (up to 98 %) [2]. But longer operation time and frequent donor site complications (up to 49 %) are adverse effects [3]. These problems do not occur if allogenic bone material is used. On the other hand, this can theoretically lead to infections and deteriorated fusion rates. Furthermore, the availability of allogenic bone can be limited [4, 5]. Alternatively, implants had been developed, the so-called "cages", which act as fusion devices and which mostly consist of biomaterials like titanium, carbon or polyetheretherketone (PEEK) [6 - 9]. Usually, a graft is placed inside the cage. During the healing process, these cages become enfolded by bone material within three to six months, resulting in a solid bony fusion of the disc space. Metallic cages normally lead to distinct artifacts of the operated segment on magnetic resonance imaging and computed tomography which clearly reduces the interpretation of the spinal canal after operation [10]. Also years after implantation the interpretation of images of the region is difficult because the cages remain in the body for a lifetime. Furthermore, metallic cages can lead to a reduction of bone density of the graft inside the cage (stress shielding), resulting in nonunion [11 - 13]. Absorbable implants could overcome the possible disadvantages of the existing fusion devices, but just a few are described yet [14 - 16].

Implant

Therefore, an absorbable implant was developed [17, 18]. The cage should initially ensure an adequate stiffness of the disc space, support spinal fusion and degrade afterwards. A hybrid structure of absorbable magnesium and absorbable polymer was developed, consisting of a magnesium skeleton infiltrated with an absorbable polymer. The polymer was expanded to create microcellular foam. By the combination of a rather rigid absorbable material like magnesium with an elastic absorbable polymer, the mechanical properties may be improved compared with conventional fusion cages and the degradation of the absorbable magnesium may be retarded. To prevent any inflammatory reactions, active ingredients can be integrated into the polymer.

For the magnesium skeleton the magnesium alloy AZ31 (Al (2.5 - 3.5 %), Zn (0.6 - 1.4 %), Mn (0.2 - 1 %), Si (max. 0.3 %)) was selected, the polymer used is poly-ε- caprolactone (PCL) (supplier: Boehringer Ingelheim Pharma GmbH & Co. KG, Ingelheim am Rhein, Germany).

The magnesium skeleton was produced by investment casting. Two different designs were under investigation (Figure 1). Design 1 is a more open structure and has a lower mass than design 2.

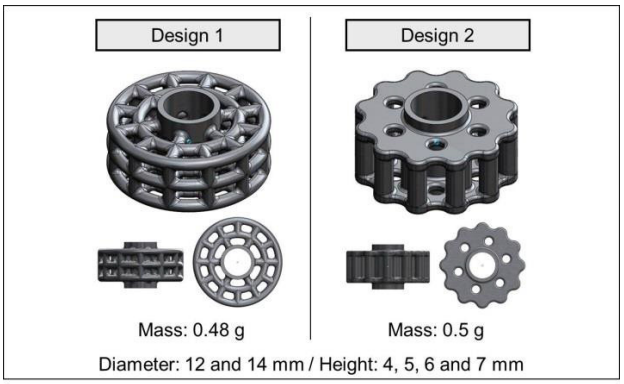

Figure 1. Two different designs for the magnesium skeleton were developed.

The lower mass of magnesium of design 1 results in a higher amount of polymer in the implant and a lower compression strength is expected. Furthermore, the degradation behavior of the cage is supposed to be influenced by the design of the magnesium skeleton.

For the infiltration of the magnesium skeleton with plastic and the subsequent foaming of the plastic, modular molds were built to enable the production of differently sized cylindrical implants (diameter 12 mm and 14 mm, height 4 mm, 5 mm, 6 mm and 7 mm), all with a cylindrical cavity in the center with a diameter of 3.5 mm. The mold for the infiltration of the magnesium skeleton with plastic can be evacuated by a vacuum pump (Figure 2).

The mold's temperature can be controlled by a heating band and a thermocouple in the mold. The mold consists of three parts: a fixed upper and lower plate and an exchangeable middle plate, which specifies the implant's height and diameter. First, the magnesium skeleton is inserted into the mold and heated up to 100 °C. Then, the material is manually filled into the sprue channel and melts as a result of the heat from the heating band. The vacuum pump is activated and the melt is filled into the mold by a cylinder. Finally, the heating band is removed and the mold is cooled down

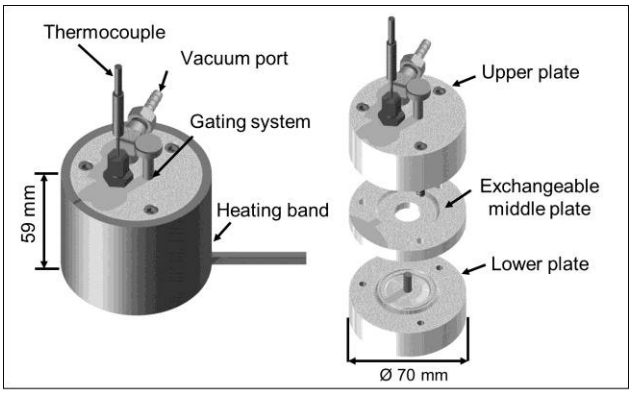

Figure 2. Mold for the infiltration of the magnesium skeleton with polymer.

In order to foam the plastic, the CESP-process (Controlled Expansion of Saturated Polymers) [19] is applied. The unfoamed part is pressurized on 60 bar with carbon dioxide at 50 °C for three hours in an autoclave. The CO_2 diffuses into the part, which leads to a reduction of the glass transition temperature of the polymer. After saturation of the polymer, the autoclave is decompressed. Due to the rapid drop of pressure the oversaturation with CO_2 leads to the foaming of the polymer. For this process, another mold was developed. It is equipped with bits with different sizes of the cavity to produce different sized implants. Small ducts enable the CO_2 to be absorbed by the polymer. The final implant is shown in Figure 3.

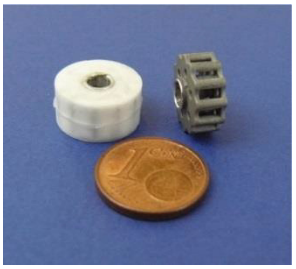

Figure 3. Hybrid magnesium-polymer fusion cage.

In vitro investigation

The mechanical properties of the implants and the polymer were investigated by means of compression tests and tensile tests [17].

The failure load of the magnesium skeleton with design 1 and design 2 without polymer found in compression tests with steady movement is 5995 ± 299 N respectively 8625 ± 157 N (Figure 4). The measured failure load of the cages infiltrated with microcellular PCL with design 1 and 2 is 10492 ± 322 N and 11452 ± 657 N (Figure 4). In case of compression tests of 8 ovine vertebral endplates an average maximum compression force was determined at 5795 ± 1215 N (Figure 4).

The stress-strain-curves arising of the tensile tests of the foamed specimens do not have a yield stress (Figure 4) in contrast to unfoamed PCL specimens tested elsewhere [20] (Figure 5). Furthermore, the modulus of elasticity of unfoamed PCL is 487 MPa [20] compared to 135 ± 11 MPa for the foamed tensile rods. Thus, foaming of the specimens results in a modulus of elasticity in the scale of one third of unfoamed PCL. The modulus of elasticity of the magnesium alloy AZ31 is 45 GPa [21] and of cortical and cancellous bone is 7 to 30 GPa and 5 to 50 MPa, respectively [22]. Therefore, the modulus of elasticity of the implant and the vertebra is expected to be in the same scale.

Nevertheless, the results indicate that the newly designed cage can be subject for further investigations, also in vivo investigations in a sheep model.

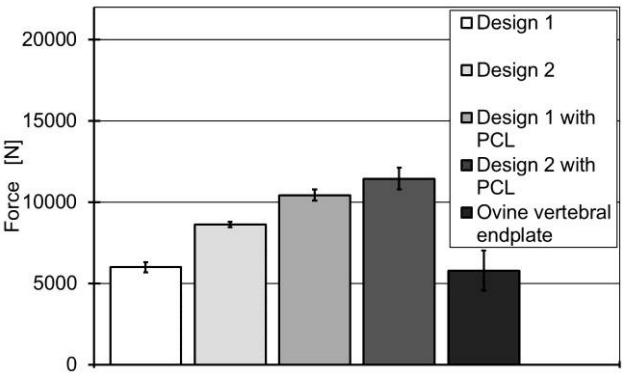

Figure 4. Failure load of the magnesium skeleton without polymer, infiltrated with microcellular PCL and of 8 vertebral endplates of ovine cadaveric spines measured in compression tests with steady movement

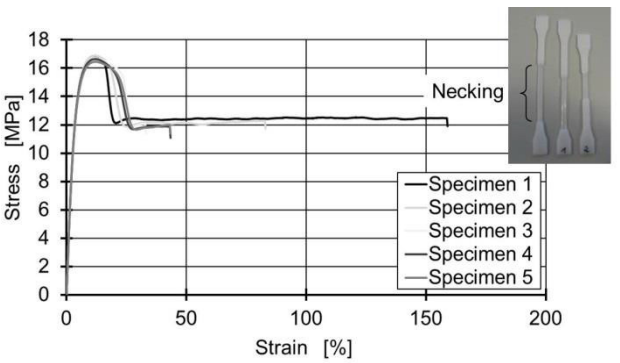

Figure 5. Stress-strain-curves of unfoamed PCL obtained from tensile tests according to DIN-EN-ISO 527 [20].

In vivo investigation

In vivo investigations were carried out with 24 healthy female full-grown blackcap sheep [18]. They were divided into four groups with study endpoints of 3, 6, 12, and 24 weeks after surgery. All sheep had the same operation with insertion of the bioabsorbable cage in one disc space and implantation of an autologous bone graft in a second intervertebral space with the intermediate disc space (C4/5) left intact. The distribution of the two different kinds of implants to the segments C3/4 and C5/6 was randomized, so in each group three animals had the magnesium-PCL cage in C3/4 and the autologous bone in C5/6 and three animals had the magnesium-PCL cage in C5/6 and the autologous bone in C3/4. Due to this distribution all sheep could act as their own comparison group (magnesium-PCL against bone). The first part of the operation consisted of taking an autologous tricortical bone block from the right iliac crest. Then, a standard anterolateral approach to the cervical spine was performed. The discs C3/4 and C5/6 were completely removed while maintaining the posterior longitudinal ligament. The optimal size (height and depth) of the magnesium-PCL cage and the bone graft was defined with the help of a dummy device. The correctly dimensioned implant was centrally inserted into the empty disc space (Figure 6A, B). Finally, a titanium plate (ABC2 Anterior Cervical Plating System by Aesculap AG & Co. KG, Tuttlingen, Germany) was fixed resulting in a primary stable construction (Figure 6C). In the pilot phase, which included the operation of three sheep, a Caspar plate (Aesculap AG & Co. KG, Tuttlingen, Germany) was used. Due to implant related problems in the first two cases plates and screws were changed to the ABC2 system.

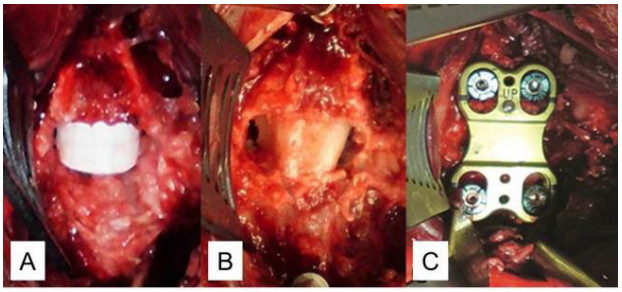

Figure 6. Intraoperative images of the disc space with implants (anterior view). A Magnesium-PCL cage. B Bone graft. C Additional stabilization with plate.

In the postoperative period no kind of cervical collar was used, so the mobilization was not limited. General and neurological examination took place daily during the first 10 days after surgery and every three days later on. The sheep (each six animals per group) were sacrificed after 3, 6, 12, and 24 weeks postoperatively by pentobarbital sodium overdose. Directly after euthanasia the whole cervical spines (C1-C7) were taken and then the C3/4 and C5/6 motion segments were harvested en bloc to perform X-rays of the 48 motion segments.

Immediately postoperatively, a roentgenogram of the whole cervical spine in lateral view was made. Subsequently, dependent on the time of euthanasia, the lateral X-rays were regularly repeated after 3, 6, 12, and
24 weeks to assess the implant (cage and bone graft) and to detect any hardware problems with the plate-screw- construct and to identify any gas accumulation. In order to analyze the rate of interbody fusion, only the radiographs of the monosegments C3/4 and C5/6 taken at the time of the animals' death were encoded and reviewed in a blinded fashion according to the threepoint radiographic score (RS) described by *van Dijk et al.* (Table 1) [13, 23].

Intraoperative fluoroscopy and directly postoperative lateral radiographs showed adequate positioning of all interbody fusion devices as well as of the plate osteosynthesis. In contrast to the Caspar plate, which showed relevant problems like screw loosening and sinking in two of three cases, the ABC2 plate worked perfectly without any signs of screw loosening or sinking or breakage at all.

RS	Description
RS 0	Pseudarthrosis
RS 1	Ingrowth of bone with the cage securely fixed to the vertebral bone above and below, but with a radiolucent discontinuity in the fusion mass
RS 2	Arthrodesis with solid bone bridging the fusion area

Table 1. Radiographic score (RS) to determine the rate of interbody fusion [13, 23]

Table 2 summarizes the results of the fusion assessments at the study endpoints after 3, 6, 12, and 24 weeks. Already after 6 weeks, most of the operated levels showed a radiographic score of 1 (RS 1) independent of the implant (magnesium-PCL cage or bone block). A similar distribution was found after 12 weeks with no motion segment demonstrating a pseudarthrosis (RS 0). After 24 weeks, 10 of 12 treated disc spaces (83.3%) showed radiologically solid bone bridging of the fusion area meaning a successful arthrodesis (RS 2). On the basis of the radiographic score, both implant types showed very similar behavior regarding the osseointegration with no obvious difference between them at any time of follow- up. After 12 and 24 weeks, no difference between the rate of interbody fusion of both the magnesium-PCL cage and the bone graft were found. It is noticeable, that after 24 weeks a remarkable bone bridging was seen anterior to all operated segments

After 3 weeks (n=6)	RS 0	RS 1	RS 2
Bone graft	4	2	0
Magnesium-PCL cage	2	4	0
After 6 weeks (n=6)	**RS 0**	**RS 1**	**RS 2**
Bone graft	0	5	1
Magnesium-PCL cage	1	4	1
After 12 weeks (n=6)	**RS 0**	**RS 1**	**RS 2**
Bone graft	0	5	1
Magnesium-PCL cage	0	5	1
After 24 weeks (n=6)	**RS 0**	**RS 1**	**RS 2**
Bone graft	0	1	5
Magnesium-PCL cage	0	1	5

Table 2. Rate of interbody fusion at the time of euthanasia (after 3, 6, 12, and 24 weeks) according to three-point radiographic score (RS) of C3/4 and C5/6 motion segments.

(6 with magnesium-PCL cage, 6 with iliac crest) connecting both adjacent vertebrae which indicated a complete solid fusion (Figure 7A). These findings were only inconstantly observable after 12 weeks and never visible after 3 or 6 weeks (Figure 7B, C).

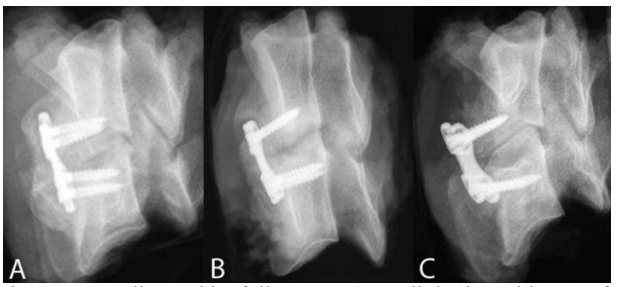

Figure 7. Radiographic follow-up. A Radiologic evidence of solid arthrodesis with complete bone bridging anterior to the motion segment and solid interbody fusion after 24 weeks, RS 2 (magnesium-PCL implant C3/4), but also with persistent evidence of the skeletal structure of the magnesium-PCL cage. B Radiolucent discontinuity in the interbody fusion mass and incomplete bone bridging anterior to the motion segment after 12 weeks, indicating RS 1 (bone graft C5/6). C No signs of interbody fusion after 6 weeks, RS 0 (bone graft C3/4).

Another point of interest was a gas accumulation in front of the disc space which was replaced by the magnesium-PCL device, which is a known phenomenon as magnesium releases hydrogen during the corrosion process. At the lateral radiographic control after 3 weeks, a certain amount of gas collection was recognized in 50 % (12 of 24 magnesium-PCL cages) of the sheep.

Conclusions

The results of the in vitro investigations indicate, that the mechanical properties of the newly developed magnesium-PCL device are sufficient for use as a fusion cage for the cervical spine. Furthermore, the in vivo investigations indicate that the developed hybrid structure appears to be suitable for usage as an absorbable fusion cage for the cervical spine.

Both types of implants (magnesium-PCL cage and bone graft) showed very similar behavior on the basis of the radiographic classification, regarding the tendency to osseointegration with no obvious difference between them at any time of the follow-up period and with an almost always complete arthrodesis after 24 weeks. These findings are worth to be analyzed more exactly regarding the characteristics of the experimental magnesium-PCL implant and to allow a comprehensive statement about the in vivo and in vitro

behavior of the tested bioabsorbable cage by further investigations, including µ-CT as well as biomechanical and histological analysis to obtain more information regarding the degradation, the stiffness and osseointegration parameters.

The research project (344ZN) of the Forschungsvereinigung Kunststoffverarbeitung was sponsored as part of the "industrielle Gemeinschaftsforschung und -entwicklung (IGF)" by the German Bundesministerium für Wirtschaft und

Technologie (BMWi) due to an enactment of the German Bundestag through the AiF. We would like to extend our thanks to all organizations mentioned.

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Annual Golf Outing 2014 *By Michael Arney*

Networking, Relaxation and Fun at the Upper Midwest SPE Annual Golf Outing

On a warm, partly cloudy August morning, 24+ golfers met at the Oak Marsh Golf Course in Oakdale, MN for a fun, relaxing day of golf. This event is always the highlight of the year for our chapter, where many different people from all over the 5 state area, representing many different companies converge on Oak Marsh for a day of fun and relaxation. We began in the morning as all the players assembled at the club house to find their golf cart which was well equipped with balls, tees, scorecard, a GPS map, and a beverage cooler. Everyone began their round of 18 holes with the 10:00 am shotgun start, and played using the four-person scramble rules. Lunch was provided at noon; so everyone returned to the clubhouse, retrieved their lunch, and then returned to the course to continue their round. The team from Vistatek was playing exceptionally well and in the end proved to be the better group of golfers. By 3:30 pm all the rounds of golf were finished and we returned to the clubhouse for prizes, refreshments, prizes, networking activities and prizes. Did I mention that there were a lot of prizes? In the end, everyone had a good time and look forward to next year.

Everyone enjoyed a full day of golf using the four-man scramble format.

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Office Hours: 9:00 a.m. - 5:00 p.m (Eastern Time)

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Matt Havekost
Advanced Technology Systems
255 Roselawn Ave E, Ste 45
St. Paul, MN 55117
Office: 651-489-6990
Cell: 952-484-7436
mhavekost@advtek.com

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Vadnais Heights, MN 55127
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dan@vistatek.com

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