3D cell-laden polymers to release bioactive products in the eye

Millions of people worldwide suffer from debilitating, progressive, and often permanent loss of vision without any viable treatment options. The complex physiological barriers of the eye contribute to the difficulty in developing novel therapies by limiting our ability to deliver therapeutics in a sustained and controlled manner; especially when attempting to deliver drugs to the posterior eye or trying to regenerate the diseased retina. Cell-based therapies offer a significant potential advancement in these situations. In particular, encapsulating, or immunoisolating, cells within implantable, semi-permeable membranes has emerged as a clinically viable means of delivering therapeutic molecules to the eye for indefinite periods of time. The optimization of encapsulation device designs is occurring together with refinements in biomaterials, genetic engineering, and stem-cell production, yielding, for the first time, the possibility of widespread therapeutic use of this technology. Here, we highlight the status of the most advanced and widely explored iteration of cell encapsulation with an eye toward translating the potential of this technological approach to the medical reality.
3D-printed bioactive scaffolds from nanosilicates and PEOT/PBT for bone tissue engineering

Additive manufacturing (AM) has shown promise in designing 3D scaffold for regenerative medicine. However, many synthetic biomaterials used for AM are bioinert. Here, we report synthesis of bioactive nanocomposites from a poly(ethylene oxide terephthalate) (PEOT)/poly(butylene terephthalate) (PBT) (PEOT/PBT) copolymer and 2D nanosilicates for fabricating 3D scaffolds for bone tissue engineering. PEOT/PBT have been shown to support calcification and bone bonding ability in vivo, while 2D nanosilicates induce osteogenic differentiation of human mesenchymal stem cells (hMSCs) in absence of osteoinductive agents. The effect of nanosilicates addition to PEOT/PBT on structural, mechanical and biological properties is investigated. Specifically, the addition of nanosilicate to PEOT/PBT improves the stability of nanocomposites in physiological conditions, as nanosilicate suppressed the degradation rate of copolymer. However, no significant increase in the mechanical stiffness of scaffold due to the addition of nanosilicates is observed. The addition of nanosilicates to PEOT/PBT improves the bioactive properties of AM nanocomposites as demonstrated in vitro. hMSCs readily proliferated on the scaffolds containing nanosilicates and resulted in significant upregulation of osteo-related proteins and production of mineralized matrix. The synergistic ability of nanosilicates and PEOT/PBT can be utilized for designing bioactive scaffolds for bone tissue engineering.

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A Protein-Based, Water-Insoluble, and Bendable Polymer with Ionic Conductivity: A Roadmap for Flexible and Green Electronics

Proteins present an ecofriendly alternative to many of the synthetic components currently used in electronics. They can therefore in combination with flexibility and electroactivity uncover a range of new opportunities in the field of flexible and
green electronics. In this study, silk-based ionic conductors are turned into stable thin films by embedding them with 2D nanoclay platelets. More specifically, this material is utilized to develop a flexible and ecofriendly motion-sensitive touchscreen device. The display-like sensor can readily transmit light, is easy to recycle and can monitor the motion of almost any part of the human body. It also displays a significantly lower sheet resistance during bending and stretching regimes than the values typically reported for conventional metallic-based conductors, and remains fully operational after mechanical endurance testing. Moreover, it can operate at high frequencies in the kilohertz (kHz) range under both normal and bending modes. Notably, our new technology is available through a simple one-step manufacturing technique and can therefore easily be extended to large-scale fabrication of electronic devices.

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**Combating Microbial Contamination with Robust Polymeric Nanofibers: Elemental Effect on the Mussel-Inspired Cross-Linking of Electrospun Gelatin**

Designing biocompatible nanofibrous mats capable of preventing microbial colonization from resident and nosocomial bacteria for an extended period remains an unmet clinical need. In the present work, we designed antibiotic free durable antimicrobial nanofiber mats by taking advantage of synergistic interactions between polydopamine(pDA) and metal ions with varying degree of antimicrobial properties (Ag⁺, Mg²⁺, Ca²⁺, and Zn²⁺). Microscopic analysis showed successful pDA-mediated cross-linking of the gelatin nanofibers, which further improved by the inclusion of Ag⁺, Mg²⁺, and Ca²⁺ ions as supported by mechanical and thermal studies. Spectroscopic results reinforce the presence of strong interactions between pDA and metal ions in the composite nanofibers, leading to generation of robust polymeric nanofibers. We further showed that strong pDA–Ag interactions attenuated the cell cytotoxicity and anticell proliferative properties of silver ions for immortalized keratinocytes and primary human dermal fibroblasts. pDA–Ca²⁺/Zn²⁺ interactions rendered the composite structure sterile against methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant *Enterococcus faecium* strains, whereas the silver ion-incorporated composite mats displayed broad spectrum antibacterial activity against both Gram-positive/-negative bacteria and yeast strains. We showed that the strong pDA–Ag interactions help retaining long-term antimicrobial activity of the mats for at least 40 days while attenuating mammalian cell cytotoxicity of silver ions for skin cells. Overall, the results suggest the potential of pDA–metal ion interactions for engineering sterile nanofibrous mats and expanding the antibiotic armamentarium against drug-resistant pathogens.
Enzymatic Crosslinked Gelatin 3D Scaffolds for Bone Tissue Engineering
Bone tissue engineering is an emerging medical field that has been developed in recent years to address pathologies with limited ability of bones to regenerate. Here we report the fabrication and characterization of microbial transglutaminase crosslinked gelatin-based scaffolds designed for serving as both cell substrate and growth factor release system. In particular, morphological, biomechanical and biological features have been analyzed. The enzyme ratio applied during the fabrication of the scaffolds affects the swelling capacity and the mechanical properties of the final structure. The developed systems are not cytotoxic according to the biocompatibility tests. The biological performance of selected formulations was studied using L-929 fibroblasts, D1 MSC and MG63 osteoblasts. Moreover, scaffolds allowed efficient osteogenic differentiation and signaling of MSCs. MSC cultured on the scaffolds not only presented lower proliferative and stemness profile, but also increased expression of osteoblast-related genes (Col1a1, Runx2, Osx). Furthermore, the in vitro release kinetics of vascular endothelial growth factor (VEGF) and bone morphogenetic protein -2 (BMP-2) from the scaffolds were also investigated. The release of the growth factors produced from the scaffolds followed a first order kinetics. These results highlight that the scaffolds designed and developed in this work may be suitable candidates for bone tissue regeneration purposes.
Flexible Electronics: A Protein-Based, Water-Insoluble, and Bendable Polymer with Ionic Conductivity: A Roadmap for Flexible and Green Electronics (Adv. Sci. 5/2019)

In article number 1801241, Alireza Dolatshahi-Pirouz and co-workers develop an ultra-sensitive, but low-cost electrode with a broad range of exciting properties brought about through a simple “design and mixing procedure.” As examples, a touch panel screen for use in foldable electronics and a human motion sensitive device are manufactured with the electrode.
Advances in stem cell therapy for cartilage regeneration in osteoarthritis

Introduction: Osteoarthritis (OA) is a progressive joint disease that compromises the structural integrity of cartilage tissue. Conventional treatments based on medication or surgery are nowadays inefficient and cell-based therapy has emerged as one of the most promising methods for cartilage regeneration. The first therapy developed for cartilage defects was autologous chondrocyte implantation, but in the last few decades stem cells (SCs) from different sources have been proposed as a possible alternative for OA.

Areas covered: SC sources and available delivery procedures (scaffolds/hydrogels) are presented, along with the main issues arisen in this regard. Thereafter, preclinical and clinical trials performed in recent years are reviewed in order to take a glance toward the potential benefits that such therapies could deliver to the patients.

Expert opinion: SCs have proven their potential and safety for OA treatment. Nevertheless, there are still many questions to be resolved before their widespread use in clinical practice, such as the treatment mechanism, the best cell source, the most appropriate processing method, the most effective dose and delivery procedure, and their efficacy. In this sense, long-term follow-up and larger randomized controlled trials utilizing standardized and established outcome scores are mandatory to make objective conclusions.
Biopolymers for Antitumor Implantable Drug Delivery Systems: Recent Advances and Future Outlook

In spite of remarkable improvements in cancer treatments and survivorship, cancer still remains as one of the major causes of death worldwide. Although current standards of care provide encouraging results, they still cause severe systemic toxicity and also fail in preventing recurrence of the disease. In order to address these issues, biomaterial-based implantable drug delivery systems (DDSs) have emerged as promising therapeutic platforms, which allow local administration of drugs directly to the tumor site. Owing to the unique properties of biopolymers, they have been used in a variety of ways to institute biodegradable implantable DDSs that exert precise spatiotemporal control over the release of therapeutic drug. Here, the most recent advances in biopolymer-based DDSs for suppressing tumor growth and preventing tumor recurrence are reviewed. Novel emerging biopolymers as well as cutting-edge polymeric microdevices deployed as implantable antitumor DDSs are discussed. Finally, a review of a new therapeutic modality within the field, which is based on implantable biopolymeric DDSs, is given.

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Scopus rating (2014): CiteScore 16.79
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Blending Electronics with the Human Body: A Pathway toward a Cybernetic Future

At the crossroads of chemistry, electronics, mechanical engineering, polymer science, biology, tissue engineering, computer science, and materials science, electrical devices are currently being engineered that blend directly within organs and tissues. These sophisticated devices are mediators, recorders, and stimulators of electricity with the capacity to monitor important electrophysiological events, replace disabled body parts, or even stimulate tissues to overcome their current limitations. They are therefore capable of leading humanity forward into the age of cyborgs, a time in which human biology can be hacked at will to yield beings with abilities beyond their natural capabilities. The resulting advances have been made possible by the emergence of conformal and soft electronic materials that can readily integrate with the curvilinear, dynamic, delicate, and flexible human body. This article discusses the recent rapid pace of development in the field of cybernetics with special emphasis on the important role that flexible and electrically active materials have played therein.

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Scopus rating (2017): CiteScore 10.19
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Web of Science (2017): Indexed yes
Combinatorial Screening of Nanoclay-Reinforced Hydrogels: A Glimpse of the "Holy Grail" in Orthopedic Stem Cell Therapy?

Despite the promise of hydrogel-based stem cell therapies in orthopedics, a significant need still exists for the development of injectable microenvironments capable of utilizing the regenerative potential of donor cells. Indeed, the quest for biomaterials that can direct stem cells into bone without the need of external factors has been the "Holy Grail" in orthopedic stem cell therapy for decades. To address this challenge, we have utilized a combinatorial approach to screen over 63 nanoengineered hydrogels made from alginate, yaluronic acid and two-dimensional nanocla, ys. Out of these combinations, we have identified a biomaterial that these combinations, we have identified a biomaterial that can promote osteogenesis in the absence of well-established differentiation factors such as bone morphogenetic protein 2 (BMP2) or dexamethasone. Notably, in our "hit" formulations we observed a 36-fold increase in alkaline phosphate (ALP) activity and a 11-fold increase in the formation of mineralized matrix, compared to the control hydrogel. This induced osteogenesis was further supported by X-ray diffraction, scanning electron microscopy, Fourier transform infrared spectroscopy, and energy-dispersive X-ray spectroscopy. Additionally, the Montmorillonite-reinforced hydrogels exhibited high osteointegration as evident from the relatively stronger adhesion to the bone explants as compared to the control. Overall, our results demonstrate the capability of combinatorial and nanoengineered biomaterials to induce bone regeneration through osteoinduction of stem cells in a natural and differentiation-factor-free environment.

The usage of prosthetics such as retina, brain-machine and neural implants along with the projected importance of technical health aids indicates that we are entering a cybernetic era. In article number 1700931, Alireza Dolatshahi-Pirouz and co-workers discuss the advances in this field with a special focus on how flexible electronics are being used by scientists to reshape this field into a readily implementable technology.

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Self-assembled amphiphilic-dextran nanomicelles for delivery of rapamycin

Nanotechnology based drug delivery systems have been explored extensively in cancer therapy over the past decades. Among the vast number of different materials used in nanocarrier systems, natural biopolymers are most frequently used in the encapsulation of chemotherapeutic drugs. However, the low solubility of these agents within biological fluid has decreased their efficacy for inhibiting the growth of cancer cells. Herein, we have developed a new biodegradable and biocompatible drug delivery system based on Dextran. Specifically, we have prepared lipid-conjugated dextran through esterification process using stearic acid (SA) and cholesterol (Chol). In vitro toxicity studies of unloaded and rapamycin loaded nanocarriers with U87 MG cell line showed that unloaded nanocarriers were non-toxic, and the IC50 value of encapsulated rapamycin for different formulations was lower than that for free rapamycin after 24 and 48 h incubation. Also, flow cytometry analysis fully supported the time dependent uptake of the nanocarriers by the cells. These results show that the synthesized polymers can potentially be used as a self-assembled carrier for loading of hydrophobic chemotherapeutics with enhanced toxicity against tumoral cancer cells.

General information
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Organisations: Department of Micro- and Nanotechnology, Colloids and Biological Interfaces, Tarbiat Modarres University
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BFI (2017): BFI-level 1
Web of Science (2017): Impact factor 2.297
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2017): CiteScore 1.9 SJR 0.517 SNIP 0.587
Web of Science (2016): Impact factor 1.194
Scopus rating (2016): CiteScore 1.25 SJR 0.387 SNIP 0.514
Web of Science (2016): Impact factor 0.476
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.72 SJR 0.25 SNIP 0.235
Web of Science (2015): Impact factor 0.62
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.68 SJR 0.251 SNIP 0.389
Web of Science (2014): Impact factor 0.355
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.81 SJR 0.355 SNIP 0.351
Web of Science (2013): Impact factor 0.734
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.04 SJR 0.468 SNIP 0.378
Web of Science (2012): Impact factor 1.088
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.78 SJR 0.332 SNIP 0.293
Web of Science (2011): Impact factor 0.679
ISI indexed (2011): ISI indexed yes
Stability and Antimicrobial Activity of Nisin-Loaded Mesoporous Silica Nanoparticles: A Game-Changer in the War against Maleficent Microbes

Antimicrobial agents, such as nisin, are used extensively in the food industry. Here, we investigated various approaches to load nisin onto mesoporous silica nanoparticles (MSNs, 92 ± 10 nm in diameter), to enhance its stability and sustained release. The morphology, size, and surface charge of the as-prepared nanoparticles were analyzed using scanning transmission electron microscopy, dynamic light scattering, and ζ potential measurement. Nisin was either physically adsorbed or covalently attached to the variously functionalized MSNs, with high loading capacities (>600 mg of nisin g-1 of nanoparticles). The results of antibacterial activity analysis of nisin against Staphylococcus aureus showed that, despite the very low antibacterial activity of nisin covalently conjugated onto MSNs, the physical adsorption of nisin onto the unfunctionalized nanoparticles enhances its antimicrobial activities under various conditions, with no significant cytotoxicity effects on mouse fibroblast L929 cells. In conclusion, MSNs can be recommended as suitable carriers for nisin under various conditions.
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.305 SNIP 1.343
Web of Science (2016): Impact factor 3.154
Web of Science (2016): Indexed yes
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BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.25 SJR 1.267 SNIP 1.413
Web of Science (2014): Impact factor 2.912
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.44 SJR 1.43 SNIP 1.47
Web of Science (2013): Impact factor 3.107
ISI indexed (2013): ISI indexed yes
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BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.2 SJR 1.408 SNIP 1.464
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ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 2
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Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.42 SNIP 1.391
Web of Science (2010): Impact factor 2.816
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.33 SNIP 1.306
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.327 SNIP 1.338
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.252 SNIP 1.44
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.367 SNIP 1.418
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.298 SNIP 1.517
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.353 SNIP 1.489
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.152 SNIP 1.469
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.219 SNIP 1.532
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.044 SNIP 1.239
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.805 SNIP 1.307
Bioprinting technologies for disease modeling

There is a great need for the development of biomimetic human tissue models that allow elucidation of the pathophysiological conditions involved in disease initiation and progression. Conventional two-dimensional (2D) in vitro assays and animal models have been unable to fully recapitulate the critical characteristics of human physiology. Alternatively, three-dimensional (3D) tissue models are often developed in a low-throughput manner and lack crucial native-like architecture. The recent emergence of bioprinting technologies has enabled creating 3D tissue models that address the critical challenges of conventional in vitro assays through the development of custom bioinks and patient derived cells coupled with well-defined arrangements of biomaterials. Here, we provide an overview on the technological aspects of 3D bioprinting technique and discuss how the development of bioprinted tissue models have propelled our understanding of diseases’ characteristics (i.e. initiation and progression). The future perspectives on the use of bioprinted 3D tissue models for drug discovery application are also highlighted.

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Scopus rating (2017): CiteScore 1.88 SJR 0.621 SNIP 0.695
Web of Science (2017): Impact factor 1.846
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.89 SJR 0.628 SNIP 0.725
Web of Science (2016): Impact factor 1.73
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.66 SJR 0.598 SNIP 0.664
Web of Science (2015): Impact factor 1.639
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.75 SJR 0.636 SNIP 0.811
Web of Science (2014): Impact factor 1.591
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Emerging Biofabrication Strategies for Engineering Complex Tissue Constructs

The demand for organ transplantation and repair, coupled with a shortage of available donors, poses an urgent clinical need for the development of innovative treatment strategies for long-term repair and regeneration of injured or diseased tissues and organs. Bioengineering organs, by growing patient-derived cells in biomaterial scaffolds in the presence of pertinent physicochemical signals, provides a promising solution to meet this demand. However, recapitulating the structural and cytoarchitectural complexities of native tissues in vitro remains a significant challenge to be addressed. Through tremendous efforts over the past decade, several innovative biofabrication strategies have been developed to overcome these challenges. This review highlights recent work on emerging three-dimensional bioprinting and textile techniques, compares the advantages and shortcomings of these approaches, outlines the use of common biomaterials and advanced hybrid scaffolds, and describes several design considerations including the structural, physical, biological, and economical parameters that are crucial for the fabrication of functional, complex, engineered tissues. Finally, the
applications of these biofabrication strategies in neural, skin, connective, and muscle tissue engineering are explored.

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BFI (2016): BFI-level 2
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 18.5
Web of Science (2015): Impact factor 1.789
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 16.79
Web of Science (2014): Impact factor 1.703
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 15.78
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Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 14.41
Web of Science (2012): Impact factor 1.316
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 12.28
Web of Science (2011): Impact factor 1.796
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
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Web of Science (2010): Impact factor 1.804
Web of Science (2010): Indexed yes
Experimental study on heat transfer augmentation of graphene based ferrofluids in presence of magnetic field

The effect of a permanent magnetic field on the heat transfer characteristics of hybrid graphene-magnetite nanofluids (hybrid nanofluid) under forced laminar flow was experimentally investigated. For this purpose, a reduced graphene oxide-Fe3O4 was synthesized by using two-dimensional (2D) graphene oxide, iron salts and tannic acid as the reductant and stabilizer. Graphene sheets acted as the supporting materials to enhance the stability and thermal properties of magnetite nanoparticles. The thermo-physical and magnetic properties of this hybrid nanofluid have been widely characterized and it shows that the thermal conductivity increased up to 11%. The hybrid nanofluid behaves as a Newtonian fluid with liquid like behavior with superparamagnetic properties as was evident from its magnetic saturation value at 45.9 emu/g.

Moreover, the experimental heat-transfer results indicated that the heat transfer enhancement of the hybrid nanofluid compared to the control fluid (distilled water) was negligible when no magnetic field was applied. Additionally, the convective heat transfer was significantly improved under the influence of a magnetic field with a maximum enhancement of 82% in terms of the convective heat transfer properties of the hybrid nanofluid.

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Organisations: Department of Micro- and Nanotechnology, Colloids and Biological Interfaces, Sharif University of Technology, University of Malaya, Tarbiat Modarres University
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Web of Science (2017): Impact factor 3.771
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.78 SJR 1.438 SNIP 1.851
Web of Science (2016): Impact factor 3.444
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.32 SJR 1.683 SNIP 1.884
Nanoreinforced Hydrogels for Tissue Engineering: Biomaterials that are Compatible with Load-Bearing and Electroactive Tissues

Given their highly porous nature and excellent water retention, hydrogel-based biomaterials can mimic critical properties of the native cellular environment. However, their potential to emulate the electromechanical milieu of native tissues or conform well with the curved topology of human organs needs to be further explored to address a broad range of physiological demands of the body. In this regard, the incorporation of nanomaterials within hydrogels has shown great promise, as a simple one-step approach, to generate multifunctional scaffolds with previously unattainable biological, mechanical, and electrical properties. Here, recent advances in the fabrication and
application of nanocomposite hydrogels in tissue engineering applications are described, with specific attention toward skeletal and electroactive tissues, such as cardiac, nerve, bone, cartilage, and skeletal muscle. Additionally, some potential uses of nanoreinforced hydrogels within the emerging disciplines of cyborganics, bionics, and soft biorobotics are highlighted.

**General information**

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3D Printed Silicone–Hydrogel Scaffold with Enhanced Physicochemical Properties

Scaffolds with multiple functionalities have attracted widespread attention in the field of tissue engineering due to their ability to control cell behavior through various cues, including mechanical, chemical, and electrical. Fabrication of such scaffolds from clinically approved materials is currently a huge challenge. The goal of this work was to fabricate a tissue engineering scaffold from clinically approved materials with the capability of delivering biomolecules and direct cell fate. We have used a simple 3D printing approach, that combines polymer casting with supercritical fluid technology to produce 3D interpenetrating polymer network (IPN) scaffold of silicone-poly(2-hydroxyethyl methacrylate)-co-poly(ethylene glycol) methyl ether acrylate (pHEMA-co-PEGMEA). The pHEMA-co-PEGMEA IPN materials were employed to support growth of human mesenchymal stem cells (hMSC), resulting in high cell viability and metabolic activity over a 3 weeks period. In addition, the IPN scaffolds support 3D tissue formation inside the porous scaffold with well spread cell morphology on the surface of the scaffold. As a proof of concept, sustained doxycycline (DOX) release from pHEMA-co-PEGMEA IPN was demonstrated and the biological activity of released drug from IPN was confirmed using a DOX regulated green fluorescent reporter (GFP) gene expression assay with HeLa cells. Given its unique mechanical and drug releasing characteristics, IPN scaffolds may be used for directing stem cell differentiation by releasing various chemicals from its hydrogel network.

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Scopus rating (2015): CiteScore 6.05 SJR 2.105 SNIP 1.434
Web of Science (2015): Impact factor 5.583
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An ecofriendly graphene-based nanofluid for heat transfer applications

Herein, a new ecofriendly approach to generate a graphene-based nanofluid was established. Specifically, a novel mode of graphene oxide reduction through functionalization with polyphenol extracted from red wine was introduced. Comprehensive characterization methods were employed to confirm and understand the reduction process of graphene oxide in the red wine polyphenol solution. It was noted, that the deoxygenation level of the reduced graphene oxide is comparable with the levels obtained by conventional and non-ecofriendly methods. The physical and thermal properties of the generated nanofluid including chemical stability, viscosity, wettability, electrical conductivity and thermal conductivity were investigated in a comprehensive manner. A significant thermal conductivity enhancement amounting to 45.1% was obtained for a volume fraction of 4%. In addition, the convective heat transfer coefficient of the nanofluid in a laminar flow regime with uniform wall heat flux was investigated to estimate its cooling capabilities. These results, firmly confirm that the generated graphene-based nanofluid is a formidable transporter of heat and yet ecofriendly. Therefore, it's anticipate that the generated nanofluid will open a new avenue in the pursuit of ecofriendly thermal conductors for heat transfer applications.

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Electrophoretic deposition of calcium silicate-reduced graphene oxide composites on titanium substrate

Calcium silicate (CS)/graphene coatings have been used to improve the biological and mechanical fixation of metallic prosthesis. Among the extraordinary features of graphene is its very high mechanical strength, which makes it an attractive nanoreinforcement material for composites. Calcium silicate-reduced graphene oxide (CS-rGO) composites were synthesized, using an in situ hydrothermal method. CS nanowires were uniformly decorated on the rGO, with an appropriate interfacial bonding. The CS-rGO composites behaved like hybrid composites when deposited on a titanium substrate by cathodic electrophoretic deposition (EPD). Compared to a pure CS coating on Ti, the CS-1 wt% rGO coating has improved adhesion by 70%, hardness by 150% and the elastic modulus by 240%. The CS-rGO composite coatings exhibit good apatite-forming ability in simulated body fluid (SBF). Moreover, the effect of addition of rGO on morphology, adhesion and proliferation of human osteoblast cells (hFOB) was investigated in vitro.

General information

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Engineering complex tissue-like microgel arrays for evaluating stem cell differentiation

Development of tissue engineering scaffolds with native-like biology and microarchitectures is a prerequisite for stem cell mediated generation of off-the-shelf-tissues. So far, the field of tissue engineering has not full-filled its grand potential of engineering such combinatorial scaffolds for engineering functional tissues. This is primarily due to the many challenges associated with finding the right microarchitectures and ECM compositions for optimal tissue regeneration. Here, we have developed a new microgel array to address this grand challenge through robotic printing of complex stem cell-laden microgel arrays. The developed microgel array platform consisted of various microgel environments that where composed of native-like cellular microarchitectures resembling vascularized and bone marrow tissue architectures. The feasibility of our array system was demonstrated through localized cell spreading and osteogenic differentiation of human mesenchymal stem cells (hMSCs) into complex tissue-like structures. In summary, we have developed a tissue-like microgel array for evaluating stem cell differentiation within complex and heterogeneous cell microenvironments. We anticipate that the developed platform will be used for high-throughput identification of combinatorial and native-like scaffolds for tissue engineering of functional organs.

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Scopus rating (2015): CiteScore 5.3 SJR 2.034 SNIP 1.597
Incorporation of mesoporous silica nanoparticles into random electrospun PLGA and PLGA/gelatin nanofibrous scaffolds enhances mechanical and cell proliferation properties

Poly(lactic-co-glycolic.acid) (PLGA) and PLGA/gelatin random nanofibrous scaffolds embedded with different amounts of mesoporous silica nanoparticles (MSNPs) were fabricated using electrospinning method. To evaluate the effects of nanoparticles on the scaffolds, physical, chemical, and mechanical properties as well as in vitro degradation behavior of scaffolds were investigated. The mean diameters of nanofibers were 974 ± 68 nm for the pure PLGA scaffolds vs 832 ± 70, 764 ± 80, and 486 ± 64 for the PLGA/gelatin, PLGA/10 wt% MSNPs, and the PLGA/gelatin/10 wt% MSNPs scaffolds, respectively. The results suggested that the incorporation of gelatin and MSNPs into PLGA-based scaffolds enhances the hydrophilicity of scaffolds due to an increase of hydrophilic functional groups on the surface of nanofibers. With porosity examination, it was concluded that the incorporation of MSNPs and gelatin decrease the porosity of scaffolds. Nanoparticles also improved the tensile mechanical properties of scaffolds. Using in vitro degradation analysis, it was shown that the addition of nanoparticles to the nano fibers matrix increases the weight loss percentage of PLGA-based samples, whereas it decreases the weight loss percentage in the PLGA/gelatin composites. Cultivation of rat pheochromocytoma cell line (PC12), as precursor cells of dopaminergic neural cells, on the scaffolds demonstrated that the introduction of MSNPs into PLGA and PLGA/gelatin matrix leads to improved cell attachment and proliferation and enhances cellular processes.

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Injectable shear-thinning nanoengineered hydrogels for stem cell delivery
Injectable hydrogels are investigated for cell encapsulation and delivery as they can shield cells from high shear forces. One of the approaches to obtain injectable hydrogels is to reinforce polymeric networks with high aspect ratio nanoparticles such as two-dimensional (2D) nanomaterials. 2D nanomaterials are an emerging class of ultrathin materials with a high degree of anisotropy and they strongly interact with polymers resulting in the formation of shear-thinning hydrogels. Here, we present 2D nanosilicate reinforced kappa-carrageenan (κCA) hydrogels for cellular delivery. κCA is a natural polysaccharide that resembles native glycosaminoglycans and can form brittle hydrogels via ionic crosslinking. The chemical modification of κCA with photocrosslinkable methacrylate groups renders the formation of a covalently crosslinked network (MκCA). Reinforcing the MκCA with 2D nanosilicates results in shear-thinning characteristics, and enhanced mechanical stiffness, elastomeric properties, and physiological stability. The shear-thinning characteristics of nanocomposite hydrogels are investigated for human mesenchymal stem cell (hMSC) delivery. The hMSCs showed high cell viability after injection and encapsulated cells showed a circular morphology. The proposed shear-thinning nanoengineered hydrogels can be used for cell delivery for cartilage tissue regeneration and 3D bioprinting.
3D Biomaterial Microarrays for Regenerative Medicine: Current State-of-the-Art, Emerging Directions and Future Trends

Three dimensional (3D) biomaterial microarrays hold enormous promise for regenerative medicine because of their ability to accelerate the design and fabrication of biomimetic materials. Such tissue-like biomaterials can provide an appropriate microenvironment for stimulating and controlling stem cell differentiation into tissue-specific lineages. The use of 3D biomaterial microarrays can, if optimized correctly, result in a more than 1000-fold reduction in biomaterials and cells consumption when engineering optimal materials combinations, which makes these miniaturized systems very attractive for tissue engineering and drug screening applications.
Projects:

A human-gut-on-a-chip for drug delivery testing and disease modelling: breaking through the gut barrier
Taebnia, N., PhD Student, Department of Micro- and Nanotechnology
Andresen, T. L., Main Supervisor, Department of Micro- and Nanotechnology
Dolatshahi-Pirouz, A., Supervisor, Department of Micro- and Nanotechnology
Fonde
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