

Nano composites commonly used in medicine and veterinary

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Abstract

Nanocomposite in various fields were discussed and tested and show various results.

Assessment of polycaprolacton (PCL) nanocomposite scaffold compared with hydroxyapatite (HA) on healing of segmental femur bone defect in rabbits. Assessment of tricalcium phosphate/collagen (TCP/collagene) nanocomposite scaffold compared with hydroxyapatite (HA) on healing of segmental femur bone defect in rabbits. Alteration in the trace minerals of cutaneous wounds of rabbits grafted with calciumsilvern nanocomposite films Development of shampoo, soap and ointment formulated by green synthesised silver nanoparticles functionalised with antimicrobial plants oils in veterinary dermatology: treatment and prevention strategies. The impact of potential feed additive nanocomposite (AG,Cu,Fe,andMnDioxide) on eggs quality parameters of lying hens compared with metal salts.

Biomimetic synthesis of bone-like nanocomposites using the self-organization mechanism of hydroxyapatite and collagen. Synthesis and Properties of Silicone Rubber/Organomontmorillonite Hybrid Nanocomposites). Self-healing hybrid nanocomposites consisting of bisphosphonatedhyaluronan and calcium phosphate nanoparticles.

Keywords: Nanocomposite, hybrid nanocomposite, wound and bone healing.

Introduction

Nanocomposite is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometers (nm), or structures having Nano-scale repeat distances between the different phases that make up the material. In the broadest sense this definition can include porous media, colloids, gels and copolymers, but is more usually taken to mean the solid combination of a bulk matrix and nano-dimensional phase(s) differing in properties due to dissimilarities in structure and chemistry Nanocomposites are found in nature, for example in the structure of the abalone shell and bone. In mechanical terms, nanocomposites differ from conventional composite materials due to the exceptionally high surface to volume ratio of the reinforcing phase and/or its exceptionally high aspect ratio.

Nanocomposite in various fields were discussed and tested

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calciumsilver nanocomposite films. Development of shampoo, soap and ointment formulated by green synthesised silver nanoparticles functionalised with antimicrobial plants oils in veterinary dermatology: treatment and prevention strategies. the impact of potential feed additive nanocomposite (ag, cu, fe and mndioxide) on eggs' quality parameters of laying hens compared with metal salts Biomimetic synthesis of bone-like nanocomposites using the self-organization mechanism of hydroxyapatite and collagen. Synthesis and Properties of Silicone Rubber/Organomontmorillonite Hybrid Nanocomposites). Self-healing hybrid nanocomposites consisting of bisphosphonatedhyaluronan and calciumphosphate nanoparticles.

Result and discussion

Segmental bone loss due to trauma, infection, and tumor resection and even non-union results in the vast demand for replacement and restoration of the function of the lost bone. utilize novel inorganic-organic nanocomposites for biomedical applications. Biodegradable implants have shown great promise for the repair of bone defects and have been commonly used as bone substitutes, which traditionally would be treated using metallic implants. nanocomposite PCL granules exhibited a reproducible bone-healing potential [1-5].

The current state and challenges towards developing bioactive and biodegradable nanocomposite TCP/collagen, while highlighting

the promising steps taken to improve the mechanical and biological properties for application in bone regeneration. Due to rapid advances made in the field, it was not possible to include all aspects of the work. However, every effort was made to ensure that seminal works and significant research findings are included, with minimal bias. The need for bone graft materials has led to the synthesis of various materials with different properties. Various attempts have been made to exploit the novel properties of TCP/collagen nanocomposite scaffold for orthopaedic applications. In conclusion, it seems that TCP/collagen nanocomposite has an important role in the reconstruction of bone defects and can be used as scaffold in bone fractures. Nanocomposite TCP/collagen granules exhibited a reproducible bone-healing potential. It seems that TCP/collagen nanocomposite has an important role in the reconstruction of bone defects and can be used as a scaffold in bone fractures [6-10].

Based on the observations in the present study it is concluded that calcium-silver nanocomposite films could be used safely for cutaneous wound healing without any adverse effects. On the basis of biochemical changes of wounds it was concluded that the treatment of wounds with calcium-silver (45:45) nanocomposite films enables the wounds to heal early in comparison with calcium-silver (35:55) nanocomposite films [11-14].

The current study revealed that AgNPs can be synthesised with a simple method using plant extract AgNPs functionalised with mixed plant oils showed a higher antimicrobial activity compared with plant oil alone or AgNPs. AgNPs functionalised with plant oils help to maximise benefit for veterinary, pharmaceutical and biological products. Disease control in animals is multifaceted, and the more traditional emergency products are required for preventive measures. In professional hospitals and home, attention is being paid to veterinary needs. Antimicrobial products of plant origin are valuable, versatile and safe and have a crucial and specific role in controlling bacterial diseases in animals [15-20].

Introduction with feed of metal nanocomposite (Ag, Cu, Fe and Mn dioxide) affects the quantity and quality of productivity of laying hens, predominating the effect of salts of the metals, that is characterized by increased levels of egg laying during the experiment in poultry. Introduction of metals as additives in macro and nanoscale form causes changes in the pH level of egg white and yolk, but within the norms regulated by the requirements of DSTU 5028:2008 'Hen's eggs for human consumption [21-25].

The HAp/Col bone-like nanocomposite material was synthesized using the self-organization mechanism between the HAp and collagen surfaces. The composite obtained demonstrated excellent biocompatibility and biointegrative activities, equivalent to autogenous bone and much better than other artificial bone materials. The HAp/Col composite will be used in both the medical and dental fields in near future, and reduce the patients' loads including pain at the donor sites of autogenous bone after transplantation. Bone tissue reactions of the composite demonstrated osteoclastic resorption of the composite followed by new bone formation by osteoblasts, which is very similar to the reaction of a transplanted autogenous-bone. From these results, we conclude that the HAp/Col composite can be successfully utilized as an artificial bone material in both the medical and dental fields as an in vivo filler and in vitro tissue regenerator [26-29].

Organo-MMT particles could be exfoliated into ca. 50-nm thickness and uniformly dispersed in the silicone rubber matrix. PDMS molecules could be intercalated into the galleries of organo-MMT. The interlayer distance of organo-MMT expanded due to the polymer intercalation. Silicone rubber / organo-MMT nanocomposites showed excellent mechanical properties compared with the unfilled silicone rubber, which were very close to those of the aerosilica-filled silicone rubber. The decomposition temperatures of silicone rubber / organo-MMT nanocomposites were [30,31].

We have presented a non-covalently cross-linked hybrid nanocomposite, which outperforms conventional, covalently cross-linked analogs in terms of self-healing capacity as well as adhesiveness to mineral surfaces. Most importantly, these non-covalently cross-linked composites were surprisingly robust yet biodegradable upon extensive in vitro and in vivo testing, thereby confirming that cohesive nanocomposites can be developed based on reversible bonds between polymer-grafted bisphosphonate ligands and calcium ions as present on the surface of nanoscale inorganic particles. The biological observation that a hydrogel based on such reversible bonds aids in the progression of bone formation throughout the material is particularly appealing for boneregenerative applications [32-40].

Conclusion

Nanocomposites in various fields were discussed and tested. Nanocomposite PCL granules exhibited a reproducible bone-healing potential. TCP/collagen nanocomposite has a significant role in the reconstruction of bone defects and can be used as scaffold in bone fractures. Calcium-silver nanocomposite films could be used safely for cutaneous wound healing without any adverse effects. Antimicrobial products of plant origin with AgNPs are valuable, safe and have a specific role in controlling diseases. The authors believe that this approach will be a good alternative therapy to solve the continuous antibiotic resistance developed by many bacterial pathogens and will be utilised in various animal contacting areas in medicine. Introduction of NcMe with feed affect quantity and quality characteristics of laying hens productivity, predominating the effect of salts of the metals, that is characterized by increased levels of egg laying during the experiment in poultry. Bone tissue reactions of the composite demonstrated osteoclastic resorption of the composite followed by new bone formation by osteoblasts, which is very similar to the reaction of a transplanted autogenous-bone. From these results, we conclude that the HAp/Col composite can be successfully utilized as an artificial bone material in both the medical and dental fields as an in vivo filler and in vitro tissue regenerator.

References

1. Cavalcanti SC, Pereira CL, Mazzonetto R, de Moraes M, Moreira RW (2008).
2. Qingchun Z, Ke T, Zhaoyang Y, Yan Z, Wensong T, Meidong L (2012) Preparation of open porous polycaprolactone microspheres and their applications as effective cell carriers in hydrogel system. *Mater Sci Eng C* 32: 2589-2595.
3. Anderson JM, Shive MS (1997) Biodegradation and biocompatibility of PLA and PLGA microspheres. *Adv Drug Deliv Rev* 28: 5-24.
4. Hule RA, Pochan DJ (2007) Polymer nanocomposites for biomedical applications. *MRS Bull* 32: 354-359.

5. Martinez-Diaz S, Garcia-Giralt N, Lebourg M, GomezTejedor JA, Vila G, et al. (2009) In vivo evaluation of 3-Dimensional polycaprolactone scaffolds for cartilage repair in rabbits. *Am J Sports Med* 20: 1-11.
6. Kim BS, Park IK, Hoshiba T, et al. (2011) Design of artificial extracellular matrices for tissue engineering. *Prog Polym Sci* 36: 238-268.
7. Ng A, Saim AB, Tan KK, et al. (2005) Comparison of bioengineered human bone construct from four sources of osteogenic cells. *J Orthop Sci* 10: 192-199.
8. Tan KK, Shamsui BS, Chua KH, et al. (2005) Bone graft substitute hydroxyapatite scaffold seeded with tissue engineered autologous osteoprogenitor cells in spinal fusion: early result in sheep as a model. *Med J Malaysia* 60: 53-58.
9. Ishaug SL, Crane GM, Miller MJ, et al. (1997) Bone formation by three dimensional stromal osteoblasts culture in biodegradable polymer scaffolds. *J Biomed Mater Res* 36: 17-28.
10. Asran ASH, Henning S, Michler GH. (2010) Poly vinyl alcohol-collagenhydroxyapatitebiocompositenanofibrous scaffold: mimicking the key features of natural bone at the nanoscale level. *Polymer* 51: 868-876.
11. Fong J and Wood F. (2006) Nanocrystalline silver dressings in wound management: A review. *International journal of Nanomedicine* 1: 441-449.
12. Ansari MA, Jadona N S, Singh S P, Amresh Kumar and Harpal Singh (1997) Effect of approaches to wound management. *Clinical Microbiology Reviews* 14: 244-269.
13. Church D, Elsayed S, Reid O, Winston B and Lindsay R (2006) Burn wound infections. *Clinical Microbiology Reviews* 19: 403-434.
14. Nadworny P L, Wang J, Tredget E E and Burell R E (2010) Anti-inflammatory activity of nanocrystalline silver-derived solutions in porcine contact dermatitis. *Journal of inflammation* 7: 1-20.
15. Awwad AM, Salem NM. (2012) 'Green synthesis of silver nanoparticles by mulberry leaves extract', *Nanosci. Nanotechnol* 2: 125-128.
16. Sulaiman GM, Mohammed WH, Marzoog, Ballauff M, Lu Y 'Smart nanoparticles: preparation, characterization and application', *Polymer* 48: 1815-1823.
17. Foley EG, Lee SW, Hartley NJ (1946) 'The effect of penicillin on staphylococci and streptococci commonly associated with bovine mastitis', *J. Food Technol* 8: 129-133.
18. Wu D, Long M (2012) 'Low-temperature synthesis of N-TiO₂ sol and characterization of N-TiO₂ coating on cotton fabrics', *Surf. Coat. Technol* 206: 3196-3200.
19. Berger TJ, Spadaro JA, Chapin SE, Becker RO (1976) 'Electrically generated silver ions: quantitative effects on bacterial and mammalian cells', *Antimicrobial Agents Chemother* 9: 357-358.
20. Kwan KH, Liu X, To MK, Yeung KW, Ho CM, et al. (2011) 'Modulation of collagen alignment by silver nanoparticles results in better mechanical properties in wound healing', *Nanomedicine* 7: 497-504.
21. DSSU [State Committee for Technical Regulation and Consumer Policy] (2009) DSTU 5028:2008. Hen's eggs for human consumption. Specifications [Yaitsiakuriachikharchovi. Tekhnichniumovy]. Kyiv: Derzhspozhyvstandart Ukrainy.
22. Egorov I, Andrianova E, Prisyazhnaya L, Blazhinkas D, Buteykis G (2011) 'Application vilzim Multi-enzyme preparation Vilzyme for broilers' [Primeneniemul'tienzimnoykompozitsiiVilzimprivy rashchivaniitsyplyat-broylerov], *Pitsevodstvo*, 8: 21-23.
23. Kutsan AT, Roman'ko MYE, Orobchenko AL (2012) Evaluation of safety and toxicity metal nanoparticles as veterinary nanonutritsevtika prototypes, to identify systematic biomarkers in experiments in vitro and in vivo 22: 84-87.
24. Orobchenko AL, Roman'ko MYE, andKutsan AT (2014) 'Toxicological evaluation nanocomposite of metals (Ag, Cu, Fe and Mn dioxide) in the level of biochemical markers in the blood of rats in chronic experiment' [Toksikologicheskayaotsenkananokompozitametallov (Ag, Cu, Fe idvuokis'Mn)pourovnyubiokhimicheskikhmarkerovkrovikrysv usloviyakhkhronicheskogoeksperimenta], *Veterinariya, zootekhniiabiotekhnologiya* 3: 21-29.
25. Nesterov DV, Sipaylova OYu, Sizova EA, Sheyda EV. (2014) 'Comparative assessment of different methods of introduction of copper nanoparticles for exchange of toxic elements in muscle tissue broiler chickens' [Sravnitel'nayaotsenkavliyan iyarazlichnykhsposobovvvedeniyananochastitsmedinaobmentoksichnykhelementovvmyshechnoytkanitsyplyat-broylerov], *Aktual'nyeproblemytransportnoymeditsiny* 3: 146-150.
26. Itoh S, Kikuchi M, Takakuda K, Koyama Y, Matsumoto HN, et al. (2001) The biocompatibility and osteoconductive activity of a novel biomaterial, hydroxyapatite/collagen composite, and its function as a carrier of rhBMP-2. *J Biomed Mater Res* 54: 44-53.
27. MehlichDR, LeiderAS, RobertsWE(1990)Histologic evaluation of the bone/graft interface after mandibular augmentation with hydroxylapatite/purified fibrillar collagen composite implants. *Oral Surg Oral Med Oral Pathol* 70: 685-692.
28. Kikuchi M, Itoh S, Ichinose S, Shinomiya K, Tanaka J (2001) Self- organization mechanism in a bone-like hydroxyapatite / collagen nanocomposite synthesized in vitro and its biological reaction in vivo. *Biomaterials* 22: 1705-1711.
29. Marouf HA, Quayle AA, Sloan P (1990) In vitro and in vivo studies with collagen/hydroxyapatite implants. *Int J Oral Maxillofac Implants* 5: 148-154.
30. Wang YM (1992) *Organosil. Mater. Appl. Chin* 5: 11.
31. Burnside SD, Giannelis EP (1995) *Chem. Mater* 7: 1597.
32. Fakhari A, Berkland C (2013) Applications and emerging trends of hyaluronic acid in tissue engineering, as a dermal filler and in osteoarthritis treatment. *Acta Biomater* 9: 7081-7092.
33. Colen S, van den Bekerom MPJ, Mulier M, Haverkamp D (2012) Hyaluronic acid in the treatment of knee osteoarthritis a systematic review and meta-analysis with emphasis on the efficacy of different products. *Biodrugs* 26: 257-268.
34. Prestwich GD (2011) Hyaluronic acid-based clinical biomaterials derived for cell and molecule delivery in regenerative medicine. *J Control Release* 155: 193-199.
35. Chai YC, Carlier A, Bolander J, Roberts SJ, Geris L, et al. (2012) Current views on calcium phosphate osteogenicity and the translation into effective bone regeneration strategies. *Acta Biomater* 8: 3876-3887.
36. Yuan HP, Fernandes H, Habibovic P, de Boer J, Barradas AMC, et al. (2010) Osteo inductive ceramics as a synthetic alternative to autologous bone graft-ing. *PNatlAcadSciUSA* 107: 13614-13619.
37. Boanini E, Gazzano M, Rubini K, Bigi A (2007) Composite nanocrystals provide new insight on alendronate interaction with hydroxyapatite structure. *Adv Mater* 19: 2499.

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38. Cramer NB, Davies T, O'Brien AK, Bowman CN (2003) Mechanism and modeling of a thiol-ene photopolymerization. *Macromolecules* 36: 4631-4636.
39. Yang X, Akhtar S, Rubino S, Leifer K, Hilborn J, et al. (2012) Direct "click" synthesis of hybrid bisphosphonate-hyaluronic acid hydrogel in aqueous solution for biomineralization. *Chem Mater* 24: 1690-1697.
40. Russell RGG. (2011) Bis phosphonates: the first 40 years. *Bone* 49: 2-19.

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