Editorial

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Mesoporous Biomaterials: a Lexicon and Structured Bibliography of Reviews

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Accessing mesoporous and nanostructured biomaterial information can be particularly time-consuming and problematic due to the interdisciplinary nature of the field. Relevant papers can be found across a broad range of journals and various key words are needed to comprehensively retrieve information. A keyword lexicon and themed bibliography of over 250 review articles from more than 100 different journals has therefore been assembled to aid students and researchers in this expanding field. Reviews dedicated to fabrication of mesoporous materials and some key characterisation techniques are grouped together. Reviews focussed on specific medical issues like biocompatibility and toxicological testing are also provided. Medical applications that have been the focus of reviews include drug delivery, cancer therapy, medical imaging, orthopaedics, tissue engineering, biofiltration, biosensing and bioanalysis. The following mesoporous materials also have had dedicated reviews on biomedical uses: silica, silicon, silicates, metallic biomaterials, metal organic frameworks, carbonaceous materials, calcium phosphates, titania, and alumina.

The academic literature, excluding textbook and textbook chapters, was searched using the lexicon shown in table 1 to capture the field, in conjunction with “review”. Searching was conducted via Google, PubMed, Scopus, Google Scholar and Web of Science.

Reviews on mesoporous materials which focussed on non-medical applications were also excluded. Reviews based on nanoscale component structures with mesoporosity, like nanotubes, were included, whilst reviews solely on solid nanoparticles were not. The reviews found have been grouped as shown schematically in figure 1, depending on whether their emphasis is on fabrication, characterisation, medical testing or specific medical uses. General reviews which featured both medical and non-medical applications have been included, but those focussed solely on non-medical applications have not. Reviews which discuss the applicability of various characterization techniques to mesoporous materials in general, or specific mesoporous materials, were included. Most of the reviews that focus on one specific mesoporous material for one specific medical application were grouped within the medical application section, rather than the corresponding dedicated material section.

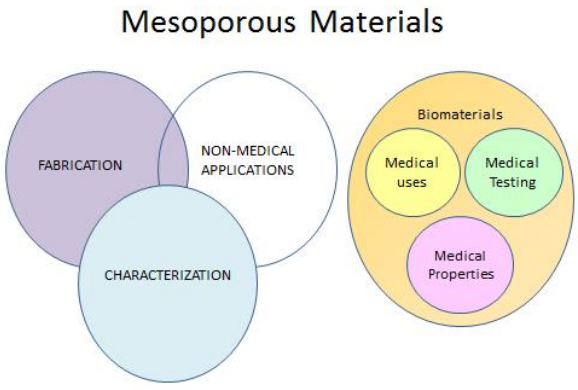

Figure 1: Grouping of retrieved reviews (coloured topics) on mesoporous materials and biomaterials. Reviews which focus on non-medical and non-biological applications were not included. Reviews which focus on general fabrication techniques and characterization techniques were included.

Nearly 300 reviews have been collated spanning more than 100 different journals. Within each group, reviews are arranged chronologically with the most recent first. The most intensively studied mesoporous biomaterial and medical application area were found to be mesoporous silica and drug delivery respectively, both with more than 50 dedicated reviews over the last decade 2005-2015.

General reviews on mesoporous materials

1. Recent advances in hybrid periodic mesostructured organosilica materials: opportunities from fundamental to biomedical applications. M.A. Wahab, J.N. Beltramini. RSC Adv. 5. 79129-79151 (2015).
2. Physicochemical properties affect the synthesis, controlled delivery, degradation and pharma-

Table 1: Lexicon of 140 search terms used within academic literature.

Biomaterial Terms & Medical Properties	Nanoscale Morphology	Materials	Properties and Characterization	Medical Processing & Testing	Medical Administration	Biomedical Applications
Absorbable	Aerocrystal	Alumina	Biochemical	Approval	Bucchal	Bioanalysis
Bioactive	Aerogel	Calcium phosphate	EDX	Bacteria	Excipient	Biofiltration
Bioadhesive	Foam	Carbon	FTIR	Biodegradability	Implanted	Biosensing
Biocidal	Hierarchical porosity	Carbonaceous	Gas adsorption	Biodurability	Injection	Cancer
Biocompatible	Hybrid	Clathrate	Magnetic	Biostability	Intramuscular	Cell culture
Biodegradable	Mesopore	Gold	Mechanical	Clinical	Intraosseous	Dental
Bioerodible	Mesoporous	Graphene	Microscopy	Cytotoxicity	Intratumoral	Drug delivery
Biofunctionality	Mesoscopic	Hydroxyapatite	NMR	Endotoxin	Intravenous	Gene delivery
Bioinert	Mesostructured	Metal	Optical	Genotoxicity	In-vitro	Imaging
Biomaterial	Nanocarrier	Metal oxide	Porosimetry	Haemolysis	In-vivo	Immunoisolation
Biomedical material	Nanocomposite	MOF	Raman	Histopathology	Maxillofacial	Orthopaedic
Haemocompatible	Nanofibrous	Polymeric	SAXS	Immunogenicity	Ocular	PDT
Implant	Nanomaterial	Silica	SEM	Inflammatory	Oral	Proteomics
Medical material	Nanopore	Silicate	Structural	Pre-clinical	Parenteral	Surgery
Nutraceutical	Nanoporous	Silicon	TEM	Regulation	Percutaneous	Surgical
Osteoconductive	Nanostructured	Silicon carbide	Thermal	Regulatory	Pulmonary	Theranostics
Resorbable	Nanotubular	Silicon nitride	Thermo-porometry	Sterilization	Subcutaneous	Therapeutic
Scaffold	Nanovector	Titania	XPS	Testing	Topical	Therapy
Thrombogenic	Porous	Zeolite	XRD	Toxicity	Transdermal	Tissue engineering
Tissue compatible	Xerogel	Zirconia	Zeta potential	Toxicology	Vascular	Wound repair

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4. Soft matter in hard confinement: phase transition thermodynamics, diffusion and flow in nanoporous media. P.Huber. J.Phys.Condens.Matter 27, 103102 (43pp) (2015).
5. Silicon: The evolution of its use in biomaterials. J.R. Henstock, L.T.Canham, S.I. Anderson. Acta Biomaterialia 11, 17-26 (2015).
6. Hollow structured mesoporous materials : chemical synthesis, functionalization and applications. Y. Li and J. Shi. Adv. Mater. 26(20) 3176-3205 (2014).
7. Polymeric nanoporous materials fabricated with supercritical CO_2 and CO_2-expanded liquids. A. Zhang, Q. Zhang, H. Bai, L. Li, J. Li. Chem. Soc. Rev. 43, 6938-6953 (2014).
8. Stimulus-responsive metal organic frameworks. S.S. Nagarkar, A.V. Desai, S.K. Ghosh. Chem. Asian J. 9(9) 2358-2376 (2014)
9. Nanofibrous scaffolds for biomedical applications. K.C.Gupta, A.Haider, Y.Choi, I.Kang. Biomater.Res. 18:5 (2014).
10. Nanoporous metal organic framework materials for smart applications. M.R. Ryder, J.C. Tan. Mater. Sci. Techn. 30(13) 1598-1612 (2014).
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