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Editorial

Guest editors' preface

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We are proud to introduce this special collection of papers in *Journal of Materials Science* dedicated to our friend, mentor and colleague Professor Larry L. Hench, who passed away on December 16, 2015, at the age of 77. Larry Hench was an undisputed giant in the field of materials science. His work was transformative in the creation of bioactive materials: a new class of biomaterial that addressed a critical application where there was an unmet need. While he is well known for his discovery of Bioglass, Larry's contributions were broad and impactful. He was a humble leader, who led by example and always had time for students and those who looked up to him. Professor Paul Hatton (University of Sheffield, UK) said it best:

> "When leaving his company, one couldn't help but be inspired to go off and try and do great things."

Larry certainly achieved great things. The discovery of Bioglass, at the University of Florida, launched a new field of biomaterials. Bioglass was the first material found to form a bond with bone. Previously, surgeons were sourcing materials from areas such as aerospace, searching for the most "inert" materials that could take the loads exerted in the human body. Larry realized that these inert materials were being "rejected" by the body because they were identified as being foreign. His Bioglass was not rejected, but instead integrated with the

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Fig. 1 Prof. Larry L. Hench with Profs. Julian R. Jones and Aldo R. Boccaccini at Larry's retirement symposium at Imperial College London (2005) (photograph courtesy of Prof. J. R. Jones).

bone and became a clinical product for bone regeneration in the mid-1990s. However, Larry did not stop there, at Imperial College, London, he worked with biologists to understand why bioactive glass was actively stimulating bone growth. He and his colleagues found that the ions released by the glass stimulate cells at the genetic level. Larry Hench published more than 800 articles that are collectively cited at a rate of >2000 cites per annum. Twelve companies were launched on technology translated from Larry's work (32 patents). Larry's textbooks defined the field of biomaterials, but he also wrote poetry, including Japanese Haiku. Among all his contributions to the scientific literature, Larry was most proud of his series of children's books featuring *Boing Boing the Bionic Cat*. This remarkable feline gained more advanced materials features in each outing, from fiber optic fur to a biosensor nose (Fig. 1).

Larry was well recognized and decorated. He was elected to the US National Academy of Engineering, the World Academy of Ceramics, and was a Fellow and Distinguished Life Member of the American Ceramics Society. Larry was the recipient of one of the most prestigious awards in Materials Science, the MRS Arthur Von Hippel Award in 1998 and the 2014 Acta Biomaterialia Gold Medal.

Larry had a long association with the *Journal of Materials Science*, he was a member of the editorial board for more than 30 years, and he later became a member of the distinguished advisory board of the journal. This special collection contains 37 papers from scientists worldwide, many of who worked directly with Larry, either as his PhD students, colleagues or academic collaborators.

The main theme of the special section is the field of bioactive materials, in particular bioactive glasses, given the remarkable legacy of Larry in the field as the inventor of Bioglass almost 50 years ago [1]. The other scientific areas in which Larry worked for many years and left important contributions, such as optical materials, electroceramics and nuclear waste encapsulation are well covered in the review of Larry Hench's legacy by Montazerian and Zanotto, the comprehensive review paper which opens the present special issue [2]. The special section includes three other review papers covering different scientific and technological aspects related to bioactive glasses, namely structure, properties and applications of phosphate glasses and fibers [3], dissolution of mesoporous silica in physiological environments [4] and applications of bioactive glasses in cranial implants [5]. Several papers deal with the investigation of novel compositions of silicate and phosphate

bioactive glasses, in particular glasses with therapeutic ion delivery capability to enhance cellular response, an area highlighted in one of the most recent papers authored by Larry Hench in 2015 [6], which reflects the importance of this topic for applications of bioactive glasses in regenerative medicine and as antibacterial agent. For example, novel bioactive silicate glasses (both melt-derived and sol–gel produced) incorporating B [7, 8], bivalent ions such as Mg, Zn, Sr and Cu [9], Li [10], Ce [11], Sr [12, 13], Cu, Zn [14], Mn [15], are discussed. The release of "classical" ions in bioactive glasses, namely Si, Ca, P, is the subject of the studies of Houreh et al. [16] and Obata et al. [17] in the context of dental pulp stem cells and osteoblast cell responses, respectively. Moreover novel Cu- and Fe-doped phosphate glasses and sol–gel-derived borate bioactive glasses are the subject of the contributions Mishra et al. [18] and Lepry et al. [19], respectively.

Another group of papers deals with fundamental studies of bioactive glasses, including compositions exhibiting mixed alkali effect [20], incorporation of radioactivatable yttrium [21] and papers dealing with the modeling (molecular dynamics simulations) of the sol–gel synthesis of bioactive glasses [22] and Sr-containing phosphate glasses [23]. Bioactive glasses are frequently combined with other materials to form composites or hybrids for a broad range of applications. Such composite systems are also featured in other papers within this special section, for example bioactive glass–biopolymer composites [24–26], hybrids [27], Ag-coated bioactive glass scaffolds [28] and antibiotic-releasing biopolymer–bioactive glass films [29]. Bioactive glasses are considered as coating materials for different substrates to provide surface bioactivity, and this aspect is covered in papers describing different coating methods involving bioactive glasses on a variety of substrates [30–34]. Other publications deal with innovative technologies to produce bioactive phosphate glass fibers [35], 3D scaffolds based on additive manufacturing methods [36], multifunctional ferrimagnetic [37] and bioinspired bioactive glass–ceramics [38] as well as novel polyphenol-functionalized bioactive glasses [39].

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We hope that with this special collection of manuscripts we have achieved a fitting contribution to the literature of bioactive glasses that is worthy of the late great scientist and scholar Professor Larry L. Hench, and it is our expectation that this publication will contribute to the recognition of his incredible impact and legacy.

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