

HKIAS Distinguished Lecture

Progress in Additive Manufacturing: From 2D Printing to 4D Printing of Structural Materials and Functional Devices Professor Jian Lu

Vice-President (Research and Technology) of CityU
Senior Fellow of CityU HKIAS

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Time : 3:00 pm - 4:30 pm

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Abstract

The additive manufacturing is now a fast-growing technology with its applications in a variety areas such as: biomedical implants, aerospace components and structures. Achieving complex-shaped architectures in high melting temperature alloys and in ceramics is still challenging. Now additive manufacturing of polymer-derived ceramics enables breakthroughs in geometrical complexity of ceramic structures. This report focuses on solving the problem of applying nanostructured ceramic materials with complex shape. The new concepts of supra-nanostructured materials and nanostructured dual phase (glass-nanocrystal) composites will be presented. The first supra-nanometre-sized dual-phase glass-crystal coatings were fabricated using the PVD process. The obtained supra nanostructured Mg alloy is consist of core of ~6 nm size crystals embedded in 2nm glassy shells. The mechanical property is 10 times higher than the conventional crystal Mg alloys. The second example is a nanostructured glass-nanocrystalline aluminum-based alloys with very high deformation capacity and strength. The potential developments of nanostructured dual phase (glasses and nano-crystals) functional materials with specific bio-compatibility or optical property and ultra-high strength can be anticipated. Also, Four-dimensional (4D) printing technology, which combines traditional three-dimensional (3D) printing with structural deformation mechanism, was developed. 4D printing enables more complex shapes to be created than is possible with conventional 3D printing. Achieving this in ceramics, however, has been hindered by the fact that 3D-printed ceramic precursors are usually rigid and thus difficult to be deformed after fully crosslinked. Here we develop new ceramic precursors that can be printed, and then transformed into ceramics with precise structural retention. Meanwhile, the flexibility of the new stretchable ceramic precursors shows great potentials in 4D printing and higher dimensional additive manufacturing. Furthermore, ceramics obtained from these printing techniques have achieved strength-scalability synergy, which broadens high temperature applications of ceramics. The directly 3D printed metallic materials has lower fatigue resistance compared to its counterparts produced by the powder metallurgy technologies including HIP. We will also introduce naturally adaptive metallic structures and their potential application in biomedical implants and post treatment of 3D printed components in Ti alloy to drastically enhance the fatigue resistance. Finally, the perspective of new 4D printing methods with associate control media will be presented.

Biography

Prof. Jian Lu is Chair Professor of Mechanical Engineering at the City University of Hong Kong. Professor Lu's primary research interest is advanced nanomaterials and its integration in mechanical and biomedical systems using the combination of experimental mechanics and mechanical simulation. He has also branched out into several other areas of interest including surface science and engineering, biomechanics, residual stresses and nanomechanics. He has published more than 360 SCI journal papers including papers in Nature (cover story), Science, Nature Materials, Nature Communications, Science Advances, Materials Today, Advanced Materials, PRL, Acta Materialia, and Journal of the Mechanics and Physics of Solids. He received the French Knight of the National Order of Merit and French Knight of the National Order of Légion d'Honneur in 2006 & 2017 respectively. He was elected as a member of the National Academy of Technologies of France in 2011. He received the Guanghua Engineering Science and Technology Award from the Chinese National Academy of Engineering in 2018. He was also elected as a Fellow of the Hong Kong of Engineering Sciences and of the Hong Kong Institute of Science in 2013.



All are welcome

Enquiries:

Tel: 3442 6611

Email: hkias@cityu.edu.hk

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