

Personal Reflections on a Career of Composite Materials Research: A Matter of Opportunities

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Abstract

The past four decades have seen tremendous changes and trends on composites materials research. During this period, I have worked on a wide range of manufacturing, characterization and mechanics problems on fibre and particulate composites based on polymer, ceramic, cement and metal matrices. The general availability of carbon and other nanomaterials in recent years has very much extended these composites from structural (e.g., stiffening, strengthening and toughening) to multi-functional (e.g., friction and wear, fire retardancy, permeability, optical transparency, thermal and electrical conductivity) applications as described in the four research monographs [1-4] referenced below. Looking back, opportunities at the time have facilitated most of my research. In this talk, I will reflect and give several examples to illustrate this point. These include:

- (a) Crack-wake bridging model for toughening of quasi-brittle materials such as fibre cements, stitched and z-pinned composites, etc.
- (b) Fracture mechanics models for evaluation of fibre/matrix interface properties from single fibre pull-out, push-in and fragmentation tests
- (c) Delamination toughening with interleaves of 2D and 3D nanomaterials
- (d) Highly transparent and conductive thin films
- (e) Electronic packaging and underfill material – high thermal conductivity, low processing viscosity and high electrical insulation
- (f) Hollow CNT/CNF hybrid electrospun anodes for LiB
- (g) Ceramic nanocomposites coatings for green manufacturing

Looking ahead, I will offer a few comments on future composites research.

References

1. B Cotterell and Y-W Mai, "*Fracture Mechanics of Cementitious Materials*", Glasgow, UK: Blackie A & P/Chapman & Hall, 294 p, 1996.
2. J K Kim and Y-W Mai, "*Engineered Interfaces in Fibre-Reinforced Composites*", Elsevier Science Publishers Ltd, Oxford, 401 p, 1998.
3. S Y Fu, B Lauke and Y-W Mai, "*Science and Engineering of Short Fibre Reinforced Polymer Composites*", Woodhead Publishing/CRC Press, Cambridge/New York, 338 p, 2009.
4. A Dasari, Z-Z Yu and Y-W Mai, "*Polymer Nanocomposites: Towards Multi-Functionality*", Springer-Verlag, London, 374 p, 2016.

Prof Yiu-Wing Mai – Short Biography

Professor Yiu-Wing Mai received his BSc(Eng), PhD and DSc degrees in mechanical engineering from the University of Hong Kong, SAR, China. He previously worked in the US (University of Michigan and NIST), the UK (Imperial College) and Hong Kong (CityU, HKU, HKUST and PolyU). He holds a University Chair in Mechanical Engineering at the University of Sydney.

Prof Mai has made significant contributions on fracture mechanics and advanced composite materials. These include the developments of asbestos-free fibre cements, superhard machining tools coated with ceramic nanocomposites, testing protocols for essential work of fracture of polymers, and improved composites manufacturing processes, such as pultrusion, thermoforming, stitching and z-pinning. His current research is focused on polymer nanocomposites for structural (fracture, fatigue, etc.) and functional (fire retardancy, permeability, optical transparency, electrical and thermal conductivities, Li-ion battery electrodes, etc.) applications.

Prof Mai received the *ICF Takeo Yokobori Gold Medal (2013)*, *UK IOM3 AA Griffith Medal (2016)* and *Engineers Australia Mechanical College AGM Michell Medal (2016)* among others. He was elected *FRS (2008)*, *FREng (2011)*, *FAA (2001)* and *FTSE (1992)*. He was appointed *AM (2010)* by the Australian Government for service to engineering.