Super small, super **STRONG**

By Michael Gibb
文：鄭智友

Really, really small, but very, very strong: this sums up the very specific advanced material that scientists at CityU have created.

What they have produced is the first-ever supra-nano magnesium alloy, according to the principle investigator, Professor Lu Jian, Vice-President (Research and Technology) and Chair Professor of Mechanical Engineering at CityU.

The innovation has just been published in top academic journal *Nature*, and has been featured as the cover page for the May 4 issue, 2017. It is the 21st century's first-ever *Nature* cover page for China in the research area of physical science (structural material or mechanical science). (http://www.nature.com/nature/journal/vaop/ncurrent/full/nature21691.html)

"This is really a major breakthrough," explained Professor Lu. "The alloy is 10 times stronger than what we refer to as a more conventional crystalline magnesium alloy, and it has super-deformation capacity two times higher than that of magnesium-based metallic glass." This means that the material is very strong but also capable of dealing with deformations in materials.

What are the benefits? One of the stresses on the human body is too many major rounds of general surgery if you get sick. Senior citizens are not always well enough for too many prolonged sessions under general anesthetic. However, the new alloy can be developed into biodegradable material that can be implanted in the human body.

So a patient would not have to undergo an operation to retrieve a medical device placed in the body during a previous operation: the implant would biodegrade after it had performed its task, vastly reducing time in hospital, cutting costs, making illness more bearable, and perhaps even saving lives.

"The material could be used as a coating for artificial joints for knees and hips, too. It has excellent wear and corrosion resistance, and may also reduce the risk of allergic reactions to metallic joints," Professor Lu said.

The electronics industry might well be interested, too. Making devices such as smart phones, tablets and laptops lighter is very

attractive. We know that devices have to weigh something, but the lighter the better seems to be the popular mantra.

Under Professor Lu's guidance, Dr Wu Ge, Postdoctoral Fellow; Dr Chan Ka-cheung, Assistant Scientific Officer; Dr Zhu Linli, Research Fellow and Associate Professor at Zhejiang University; and Dr Sun Ligang, Senior Research Associate, are dedicated to fabricating the supra-nano-dual-phase glass-crystal alloy and studying its deformation mechanism.

The supra-nano-dual-phase glass-crystal alloy film structure is one of the outcomes of this research programme. Supra-nano means that the size of each phase is less than 10 nanometres (nm), and glass is in the general amorphous phase. In fact, the basic element of this newly developed material is composed by the nanocrystalline grain (6 nm) enclosed in an amorphous glassy shell (2 nm). It represents a new family of alloy structure: suprananostructure – a world first.

The new alloy was produced using a special magnetron-sputtering technology, Professor Lu added, and its strength was enhanced by modifying the volume proportion of the crystalline phase and amorphous phase in the material. The breakthrough paves the way for developing other supra-nano-structured materials with special physical and chemical properties.

"We hope that our new material will promote really positive developments in technology for society," said Professor Lu.

全球首創**最強鎂合金**

超小、超強：這是對城大科學家創造的特殊先進材料的最貼切描述。

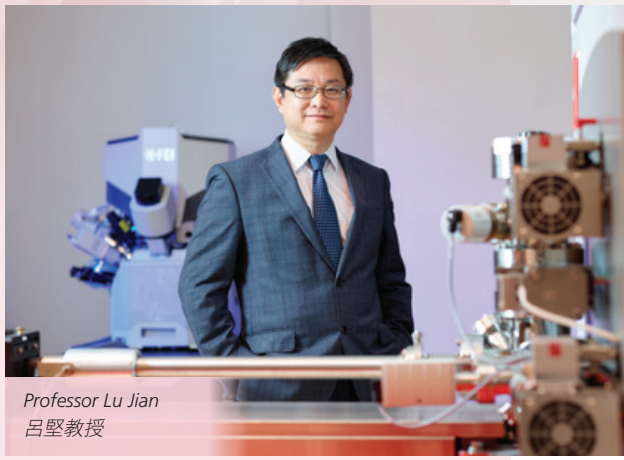
據該研究首席研究員、城大副校長（研究與科技）兼機械工程學講座教授呂堅教授介紹，他們研製出的超納鎂合金屬世界首創。

這項發明不久前發表在世界頂尖學術期刊《自然》上，並被選作2017年5月4號的封面故事。這是21世紀以來，中國的物理科學（包括結構材料、力學與機械工程）研究成果首次登上《自然》雜誌封面。（請參閱 http://www.nature.com/nature/journal/vaop/ncurrent/full/nature21691.html）

呂教授解釋說：「這確實是一項重大突破。新合金的強度較常規鎂合金晶體材料高出十倍，變形能力則比鎂基金屬玻璃高兩倍。」這表示材料不僅非常堅固，而且可以變形。

新合金有甚麼好處呢？病者要承受一次又一次的手術是對身體的一大負荷，老年人尤其難以承受在全身麻醉下一再進行長時間的手術。這種新合金可以發展成可植入人體的生物降解材料。如此一來，植入物在完成任務後會自行生物降解，患者不必再經手術取出安置在體內的醫療裝置，大大縮短住院時間、降低成本、減輕痛楚，甚至能挽救生命。

呂教授說：「這類材料未來可能用作人造膝關節和髖關節的外膜。它耐磨、抗腐蝕，我們下一步的目標是發展能降低人體對人造金屬關節產生過敏反應風險的新型超納合金。」



Professor Lu Jian
呂堅教授

電子業界也可能對這種材料感興趣。製造商總是千方百計令智能手機、平板電腦和筆記型電腦等設備變得更輕。雖然這些設備必然有一定重量，但大多數人都認為愈輕愈好。

在呂教授的指導下，博士後研究員吳戈博士、助理科學主任陳稼祥博士、研究員兼浙江大學副教授朱林利博士，以及高級副研究員孫李剛博士致力研製超納雙相-玻璃納米晶合金，並研究其變形機理。

超納雙相-玻璃納米晶合金膜結構就是這個研究的成果之一。超納意為每相結構單元均小於10納米，而玻璃意為廣義的非晶體狀態。事實上，這種全球首創的材料由6納米的超納晶和2納米的殼包裹，是超納這個新的合金結構「家族」的第一個成員。

呂教授補充說，這種新合金採用特殊的磁控濺射技術生產，通過調整材料中晶體相和非晶體相的體積比例來提高強度。這一突破為開發其他具有特殊物理和化學性質的超納結構材料開闢道路。

呂教授說：「我們希望研製的新材料能夠促進技術發展，造福社會。」

"The new alloy can be developed into biodegradable material that can be implanted in the human body."