Reprogram to pluripotency: a new logic and a chemical cocktail

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Somatic cells from animals and humans can be reprogrammed into pluripotent stem cells by pluripotency factors. Hongkui Deng and colleagues discovered that pluripotency can also be induced with exogenous lineage specifiers via balancing competing differentiation forces. In a related study they achieved, for the first time, restoration of pluripotency in adult somatic cells using a chemical cocktail alone.

Figure 1. The Fountain of Youth by Lucas Cranach the Elder. This image is in the public domain.
chemical screen and finally arrived at a cocktail of seven small molecules that effectively reprogram mouse fibroblasts into functional iPSCs that passed the most stringent functional tests. Mechanistically, the chemical combination up-regulates two pluripotency genes SOX2 and SALL4 as well as several extra-embryonic endoderm genes, including GATA4 and GATA6 [3]. This result is consistent with their first study, in which SALL4, GATA4 and GATA6 can replace OCT4 in the induction of pluripotency [2]. Together, this study not only achieved a major milestone in complete chemical reprogramming of somatic cells into a pluripotent state, but also provided new mechanistic insight underlying reprogramming. More importantly, the feasibility of chemical reprogramming of mouse cells opens doors for the future generation of safe human iPSCs for clinical applications and provides dynamic tools to demystify the black box of the reprogramming process.

In summary, focusing on genetic and chemical replacements of OCT4 in reprogramming, Deng and colleagues discovered a new logic and a chemical cocktail for reprogramming to pluripotency. Deng’s group represents one of many laboratories in China that have been making major contributions to the fields of reprogramming, stem cell biology and regenerative medicine. Given the major drive in China for biomedical research, more landmark discoveries will surely be forthcoming, moving closer to the dream of eternal youth.

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MATERIALS SCIENCE

Functionalized interleaf technology in carbon-fibre-reinforced composites for aircraft applications

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At the recent 19th International Conference of Composite Materials (ICCM-19), in Montreal, Professor Xiaosu Yi from the Beijing Institute of Aeronautical Materials, Aviation Industry Corporation of China, gave a plenary lecture on ‘How to Make the Structural Composites Multi-functional’. His lecture highlighted the recent developments from his research team in functionalized interleaf technology (FIT). Their work has improved both the electrical conductivity and the impact damage resistance of carbon-fibre-reinforced composites for aircraft applications.

Carbon-fibre-reinforced polymer (CFRP) and glass-fibre-reinforced polymer (GFRP) composite structures are widely used in today’s aerospace, green energy, marine, sport and transportation industries. These materials provide manufacturers and builders with cost-competitive alternatives to conventional metal alloys. However, the introduction of polymer composites in mainframes of modern structures presents special challenges and issues regarding their multi-functional properties (e.g. electrical and thermal conductivities) in addition to the potential risk of incurring extension of interlaminar damage under impact and fatigue loading, due to the brittle nature of the matrix resins. For example, such composite structures are poor conductors of extreme electrical currents generated by a lightning strike. Composite materials are either not electrically conductive at all under a moisture-free condition (e.g. GFRPs with electrical conductivity in the order of $10^{-16}$ [S m$^{-1}$]) or are significantly less conductive (e.g. CFRPs with the order of $10^0$–$10^1$ [S m$^{-1}$]) than metals (with the order of $10^6$–$10^7$ [S m$^{-1}$]).

Two approaches of FIT were detailed in Professor Yi’s lecture. The first approach is associated with the use of perforated amorphous phenolphthalein poly-ether-ketone (PEK-C) films as interleaves [1,2]. When an interleaved composite laminate with a thermosetting matrix (e.g. bismaleimide) is cured, highly toughened thin interlaminar regions are established with phase inversion and phase separation. The key advantage of such a technique is