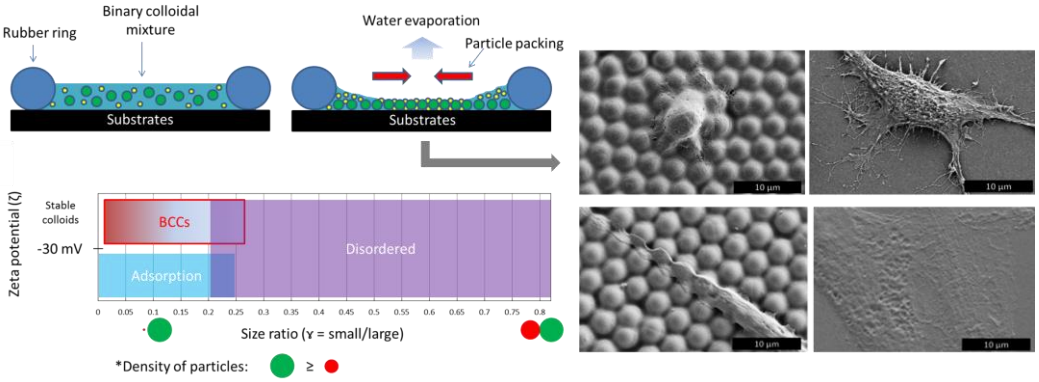
Next generation biomedical materials based on highly ordered colloid crystals

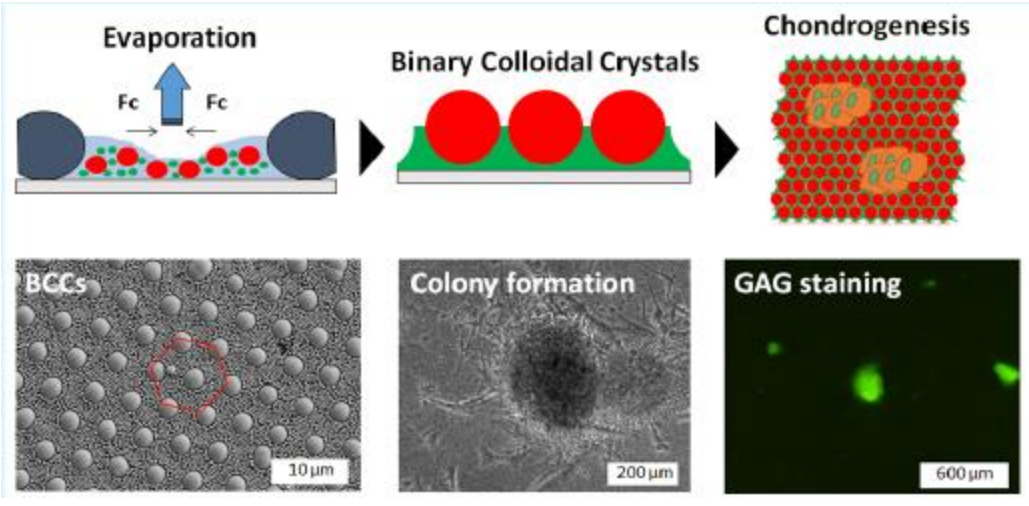
Peng-Yuan Wang, Swinburne University of Technology, 2015

The 3-year project aimed to develop a new group of complex substrates with ordered topographies and chemistries called monolayer binary colloidal crystals (BCCs) for cell culture. These new surfaces are easy to fabricate without time-consuming protocols and a need to use expensive fabrication instruments. The surface topography of the BCCs is comprised by micro- and nano-scale features which can manipulate cell focal adhesions, and in turn change the morphology and following behaviour of the attached cells. The surface chemistry of BCCs is heterogeneous which allows for the selective grafting of different biomolecules on the surface. All these advantages are desired in the field of biomaterials, advanced materials fabrication, and tissue engineering.

The first set of experiments involved screening the various combinations of binary colloidal mixtures and fabricating stable monolayers of BCCs for cell culture that included fibroblasts, osteoblasts, and human adipose-derived stem cells (hADSCs). The results showed that BCC surfaces can inhibit cell spreading in a cell type dependent manner. The outcome is published in Journal of Materials Chemistry B (see ToF below).



The second part of the study was to use these BCCs for long-term cell culture of hADSCs for osteo- and chondro-genic differentiation. The results showed that the proliferation rate on BCCs was slower than flat controls (tissue culture polystyrene, TCPS, and Si wafers). Gene expression of three chondrogenic genes, one osteogenic gene, but not adipogenic genes was up-regulated on BCCs compared with TCPS and glass controls after 1 week culture in normal medium. Using induction medium, cells were spread on surfaces in osteogenic medium while cells formed colonies on BCCs in chondrogenic medium. Gene expression of osteogenic and chondrogenic cells was both up-regulated on BCCs compared with controls in a gene-, surface-, and time-dependent manner. Immunostaining showed that osteogenic and chondrogenic cells were expressing specific bone and cartilage proteins. The outcome is published on ACS Applied Materials & Interfaces (see ToF below).



Overall, during this 3 year project a total 7 papers have been published. In addition, several collaborations were established. Some collaborations (e.g. Duke University, USA; the University of Melbourne; Tsinghua University, China) continue such as “Stem cell response to ordered nanotopographies with different aspect ratio using colloidal lithography” and “Self-assembly of monolayer crystals for photonic applications” due to this funding. Also, awards and grants have been received during 3 years including DCERA Fellowship 2015, Vice-Chancellor’s Research Excellence Early Career Award 2015, and Australia-China Young Scientists Exchange Program 2015