Nature Inspired Circular Recycling for Soft Materials (NaCRe)

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In 2070 the world will be inhabited by 11 billion people. One of the main problems humanity will have to face is the sustainability of its materials production and consumption. By then, close to 1 billion tons of plastic will be produced yearly. Even if all polymers were to be bio-sourced and bio-degradable, there would still be a huge sustainability challenge both in terms of sourcing (to avoid problems such as deforestation or competition with food production) and of disposing (as those quantities would end up polluting earth at the very least by shifting ecosystems balances in significant ways). Clearly, humanity has to move towards the principles of circular economy where materials, once produced, remain in usage for the longest possible amount of time, taxing earth the minimum possible.

Interestingly when pausing to observe Nature's main polymers (*e.g.* proteins) it is possible to admire the circularity in their use. A vast over exemplification of protein metabolism shows that when a living specie eats, it will digest protein down into its monomers (the 20 proteogenic amino-acids), then the ribosomal synthetic cell machinery in the cell will reassemble them into completely different proteins in no way related to the original ones. One could state that Nature is teaching us the ultimate circular economy example for materials use, where recycling leads to the formation of materials that have limited commonality with the original ones, with the key building blocks (amino acids or nucleic acid bases) that are constantly in use.

In this talk, I will show the progresses my group is making towards showing that natural sequence-defined polymers can indeed be recycled into other polymers that have little in common with the original ones in the laboratory. Results involving various types of proteins and of nucleic acids will be presented. Efforts to translate this concept in the world of synthetic polymers will also be introduced.