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The Biomineralisation protein Mms6, and the Development of a New Approach to Data Storage

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Extended Abstract

Finding new synthesis methods with the ability to control the size and shape of magnetic nanoparticles (MNPs) is important for a growing number of technologies. Patterning uniform MNPs onto surfaces could form a new route to bit-patterned media, potentially extending the storage capacities of magnetic hard disks to lead to a new generation of ultra-high density data storage devices. In this work we look at the how the biomineralisation protein Mms6, which was first identified by Arakaki *et al*. (2003) from the magnetotactic bacterium *Magnetospirillum magneticum* AMB-1, can be used to form MNP arrays of magnetite onto surfaces. Magnetotactic bacteria form highly uniform MNPs of magnetite inside specialised lipid organelles termed magnetosomes, and the Mms6 protein itself has a hydrophobic *N*-terminus that integrates into the magnetosome membrane to expose a magnetite interacting acidic *C*-terminal region thought to be located in the magnetosome interior. We have shown previously that Mms6 can control the formation of consistent MNPs of magnetite in microscale arrays when patterned onto functionalised gold surfaces via the soft-lithographic technique of micro-contact printing (Galloway *et al*., 2012a, b).

Recently we published a simplified variation of this approach to pattern a version of Mms6 engineered to contain an *N*-terminal cysteine, binding directly to gold and biotemplating MNP arrays of magnetite and magnetically harder cobalt-doped magnetite (Bird *et al*., 2015). This was found to have no adverse effect on the functionality of the protein, and improved the formation of highly ordered and consistent microscale arrays of magnetite nanoparticles when the protein patterned substrates were added to an aqueous mineralisation reaction. Here we look at different ways cysteine-tagged Mms6 could be used to form MNP arrays of magnetite on gold surfaces.

This process can easily be adapted with the use of alternative biomolecules to biotemplate different materials on surfaces, and we have shown previously that this approach can be used to form microscale patterns of CoPt (Galloway *et al*., 2013). These biomolecules are no longer limited to those which are found in nature, and techniques such as biopanning can be used to design made alternatives. We have also reduced pattern sizes from the nanoscale to the microscale with the use of interferometric lithography, truly bringing a bioinspired and green approach to data storage closer to reality.

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