Project Title
Ion-selective atomic force microscopy - a powerful new materials characterization technique

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Project Description
AFM is a flexible research tool that permits atomic or Å resolution imaging of substrates, either in a fluid, air or vacuum [1]. Although AFM is a popular research tool that is able to provide detailed information about the substrate such as topography, friction and adhesion, it lacks chemical specificity and may not be used to probe directly specific chemical groups pertaining to a chemical event (e.g., ion transportation through an ion channel, DNA interactions on a biosensor, lithium intercalation in a battery electrode, etc.) [2].

An adaptation of this technique commonly referred to as chemical force microscopy involves a modification of the tip, either through functionalization or the attachment of chemically specific particles, allowing AFM to be used in the selective force imaging of substrates [2]. There are many reports on applications of chemically modified AFM tips in the literature including, but not limited to, studies of molecular interactions between polymers, biomolecules and colloidal particles [2].

Ion-selective electrodes (ISEs) provide an excellent option for the chemical modification of AFM tips, as there is a selective electrode material for virtually every known ion [3,4], and this approach would enable the development of a broad technology platform that is applicable to many problems in materials science, e.g., ion transportation in biological ion channels [5,6].

The overall aim of this project is to develop an innovative approach for chemically modified atomic force microscopy (AFM) using miniaturized ISE tips, with a view to establishing a robust new imaging technique for materials science.

As an example, Figure 1 presents an AFM cantilever comprising a copper ISE tip (right-hand side), and the corresponding AFM forces measured as one samples a copper coated mica specimen (left-hand side) clearly showing that the copper ISE AFM tip can differentiate between a copper releasing and non-copper releasing substrate.

![Figure 1: A force map for a copper ISE-AFM tip as it is scanned across a copper patterned mica substrate in distilled water (left), and a scanning electron micrograph (SEM) of the ISE modified tip (right)](image)

In this project, a novel nanoparticle synthesis and characterization scheme will be applied in the preparation of high-integrity ISE-AFM tips, and these tips will be used in studies of ion channel mimetic membranes with a view to providing information on the behaviour of biological ion channels implicated in a variety of diseases. This information will be relevant and useful to the field of medicinal chemistry.

References