A novel approach for incorporating a rechargeable fluoride battery into dental materials

Fluoride is the primary therapeutic agent in controlling post-eruptive dental caries. The presence of fluoride in the mouth, in a sustained low level, is considered to be the most effective method in dental prophylaxis and in fighting caries. Many fluoride delivery systems are available (eg dentifrices and mouthwashes), which provide limited protection. Also, restorative dental materials often release fluoride; however they do not have the ability to recharge once they have depleted their fluoride content, with the exception of glass ionomer cements which, after absorption, re-release fluoride to a limited capacity. Hence, developing dental materials with the ability to maintain a constant low level of fluoride in the oral cavity, by acting as fluoride batteries, is paramount in preventing caries.

This project is concerned with developing dental materials (eg composite based fissure sealants) incorporating layered double hydroxides (LDH), which have the ability to act as rechargeable fluoride batteries. Layered double hydroxides (LDHs) consist of positively charged inorganic matrices that have proven to be successful in removal of excess fluoride from drinking water, and are also utilised in the controlled release of pharmacologically active compounds. Zn-Al layered double hydroxides (LDHs) will be synthesised and characterised followed by incorporation into a variety of experimental and commercially available dental materials. These will be studied with respect to their ability to act as rechargeable fluoride batteries. Their physicochemical properties before, after releasing fluoride and after recharging and re-releasing fluoride again, will be investigated. The effects of other metal hydroxides, in formulating LDH will also be studied.

The student will work with an interdisciplinary team of scientists, clinicians and various dental companies, thus enhancing valuable collaborating experience. He/she will gain a deep understanding and a depth of knowledge in developing and analysing dental materials as fluoride batteries. He/she will become competent across a wide range of laboratory techniques, for example, synthesising and characterisation techniques, (like 19F- MAS NMR), mechanical testing (eg compressive strengths), and interpretation of data (mathematically and statistically). He/she will also learn to think innovatively thus gaining independent thinking and problem solving skills.

References:

Requirements:
The student will need to have a background in Dental Materials Science and Dentistry. Experience in laboratory techniques, for example, characterisation techniques and mechanical testing, and a background in LDH synthesis will be will advantageous.