Queen's University Belfast

Effect of Hydration on Polyelectrolyte Multilayer Film Reinforced Bone Tissue Scaffolds

INTRODUCTION

Hydrated and dry testing of nanocomposite thin films showed drastic differences in mechanical behaviour, indicating the importance of development of films which will maintain their mechanical properties *in vivo*

- Using Layer-By-Layer (LBL) assembly, nano-composite films can be deposited to enhance the properties of 3D porous substrates, creating bone tissue scaffolds with tailorable attributes.
- LBL is a thin film fabrication process whereby the alternating deposition of oppositely charged species produces a nano-laminate composite coating.

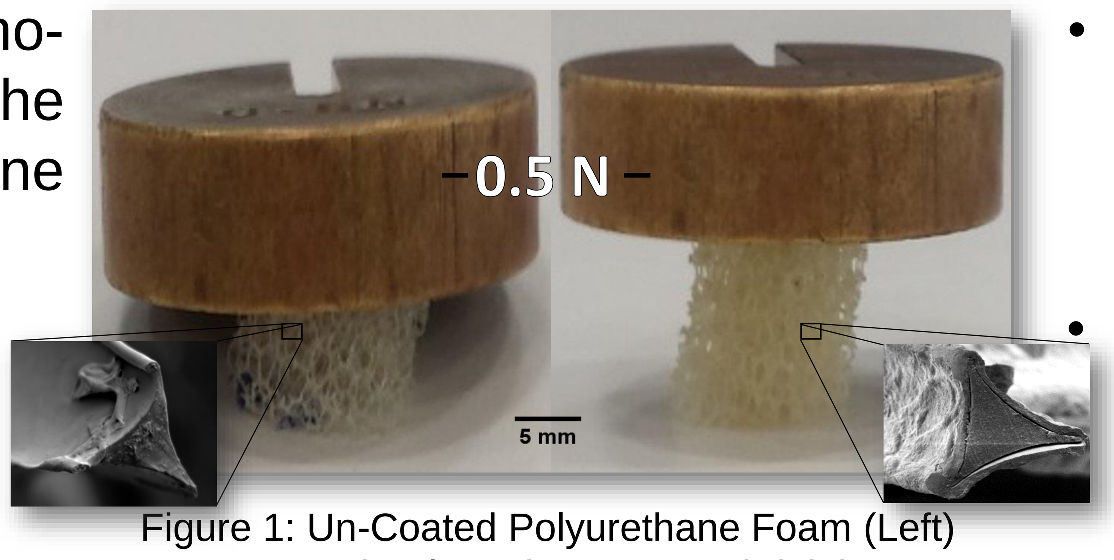


Figure 1: Un-Coated Polyurethane Foam (Left) Coated Polyurethane Foam (Right)

- These coatings are able to improve the compressive elastic modulus of 3D porous polyurethane structures by an order of magnitude.
- To ensure the films retain their function *in vivo,* investigation of the effect of DI water upon the nanocomposite coated films is being carried out.

AIM: TO STUDY EFFECTS OF HYDRATION ON MECHANICAL PROPERTIES OF POLYURETHANE FOAMS COATED WITH A NANOCOMPOSITE THIN FILM

MATERIALS AND METHODS

LBL Deposition

- Open cell polyurethane foams were subjected to alternating solutions of oppositely charged species to produce a nanocomposite thin film coating consisting of polyelectrolytes (PEI, PAA) and nanoclay.
- The sequence in Fig 2 was repeated until the desired number of layers is achieved.

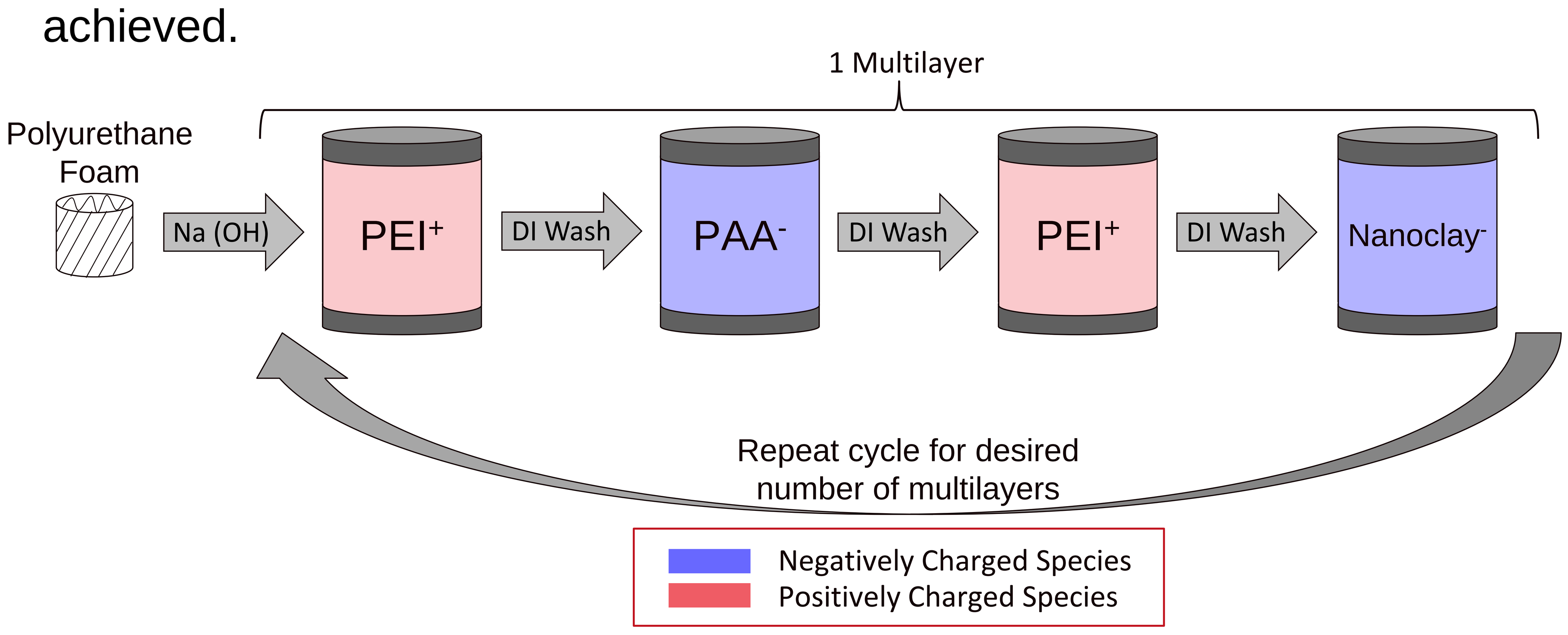


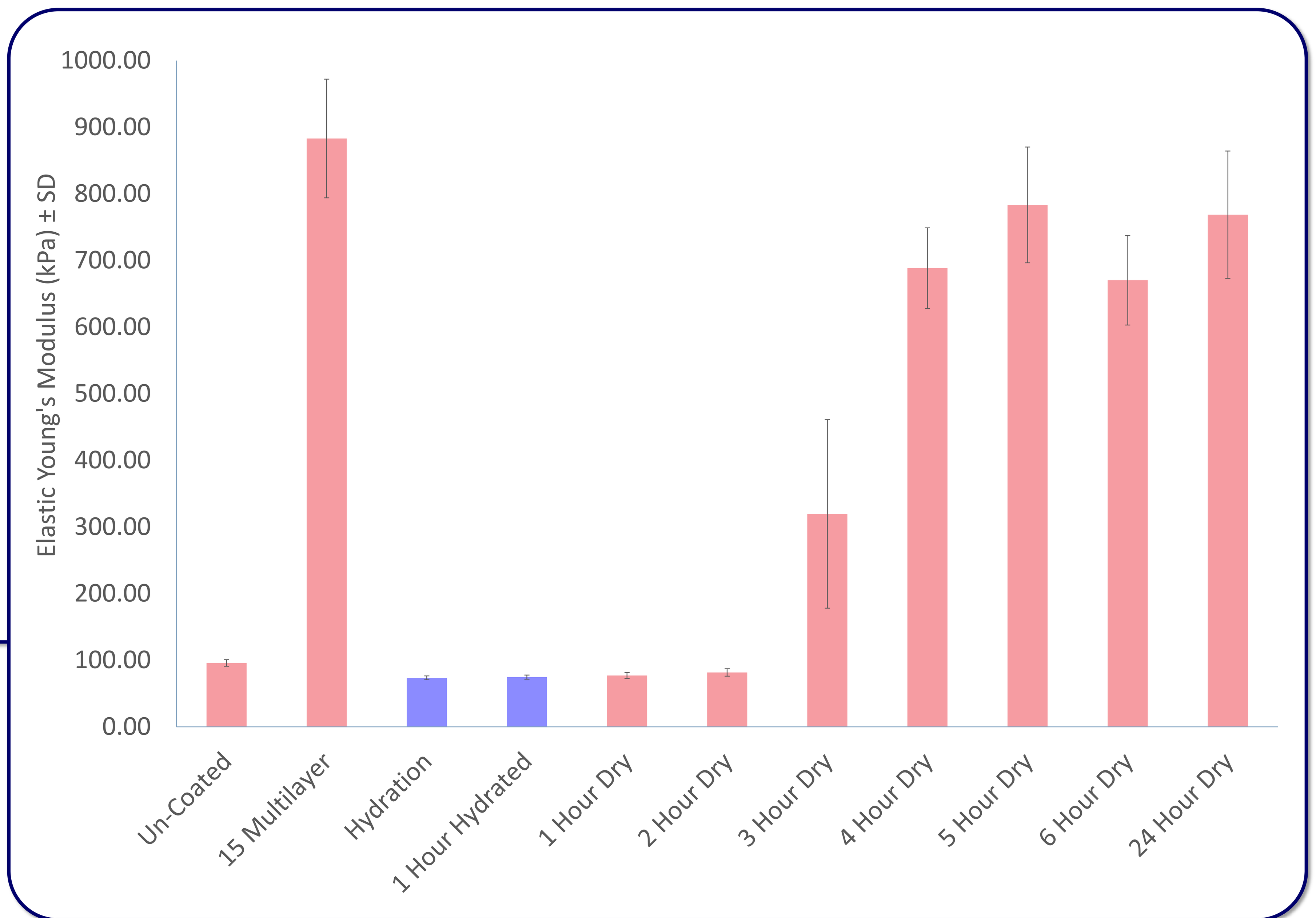
Figure 2: Schematic of Order of Oppositely Charged Species Used During LBL Deposition

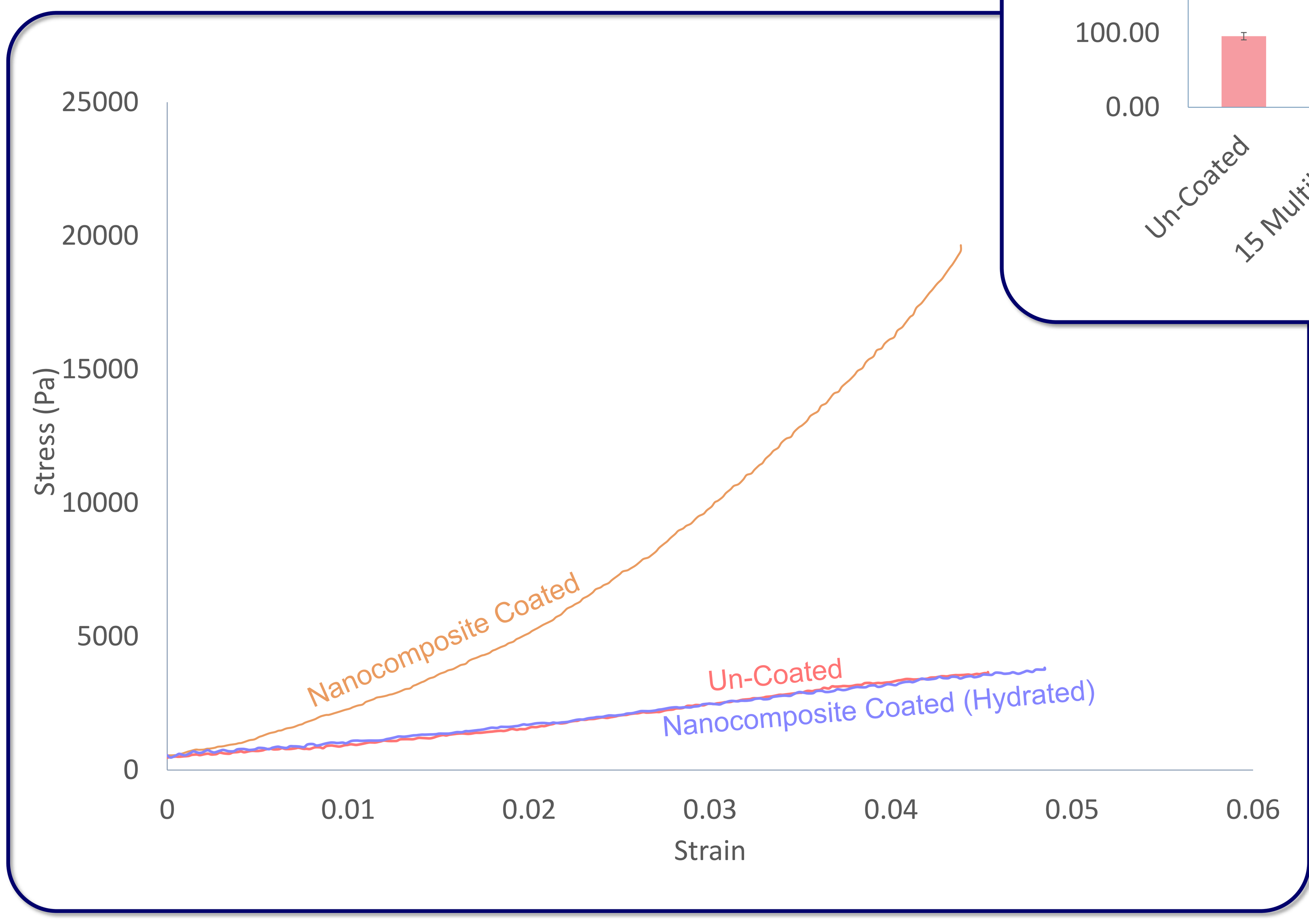
Characterisation

- Samples were mechanically tested in compression, in the elastic range, using a Stable Microsystems Texture Analyser XT2i, using a 50 N load cell at a speed of 0.5 mm/sec with a maximum displacement of 2 mm.
- Samples were tested in air immediately after immersion in DI water and again after 1 hour immersion.
- Samples were dried under controlled humidity and tested at 1 hour intervals until dry
- ESEM images were taken of coated and uncoated foam samples to analyse the surface and thickness of the film deposited, Fig 3.

RESULTS AND DISCUSSION

- The elastic modulus of the un-coated open cell foams (n = 3) was 95.33 ± 9.8 kPa. After deposition of 15 multilayers the elastic modulus of the samples increased to 882.67 ± 178.1 kPa.
- Upon hydration the elastic modulus of the samples drops to 74.33 ± 6.5 kPa, showing that upon hydration the film loses all its mechanical integrity.
- The reduction in mechanical properties may be attributed to the reported propensity of the material system to absorb water[1].





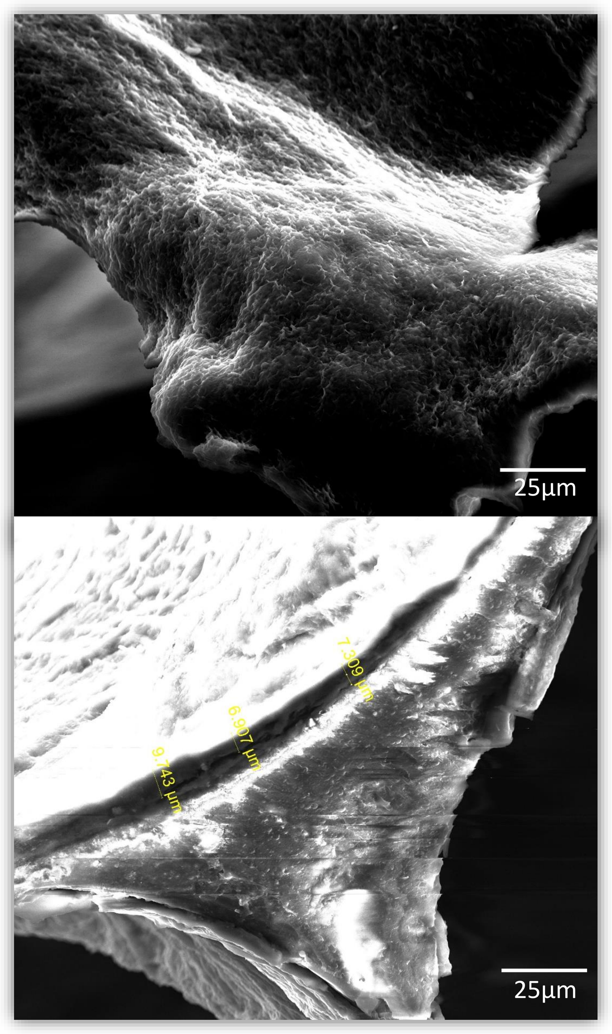


Figure 3: Film Surface (Top) Film Thickness (Bottom)

FUTURE WORK

To synthesise a bone tissue scaffold using this methodology, it must maintain its mechanical properties *in vivo,* therefore, the following experiments have been proposed. The use of:-

- Barrier layers to prevent hydration
- Cross-linking of layers to reduce chain mobility
- Confining layers to reduce swelling

[1] Podsiadlo P, et al. Exponential Growth of LBL Films with Incorporated Inorganic Sheets. Nano Lett 2008 06/01; 2014/07;8(6):1762-1770

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