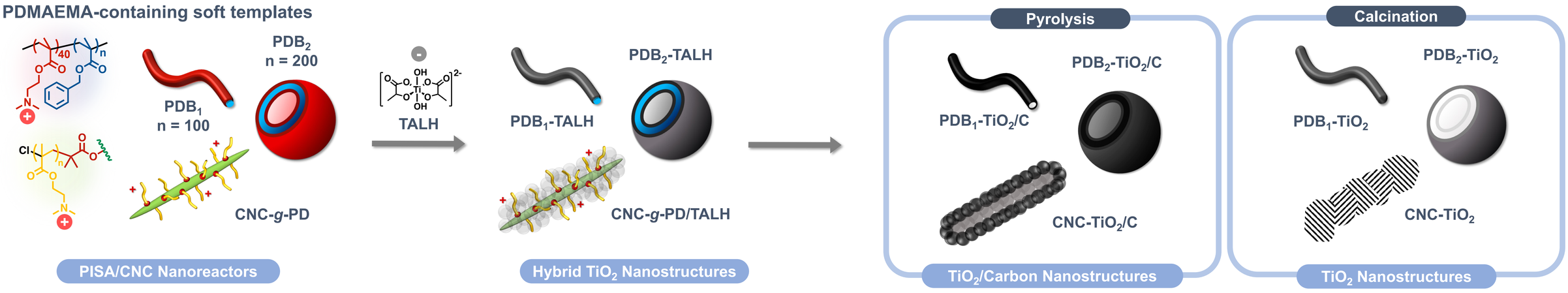
Polymerisation-Induced Self-Assembly and Cellulose Nanocrystals for the Fabrication of Nanostructured Carbon-Coated Anatase

Yen Theng (Alicia) Cheng[1,2], Chris D. Ling[2], Markus Müllner[1*]

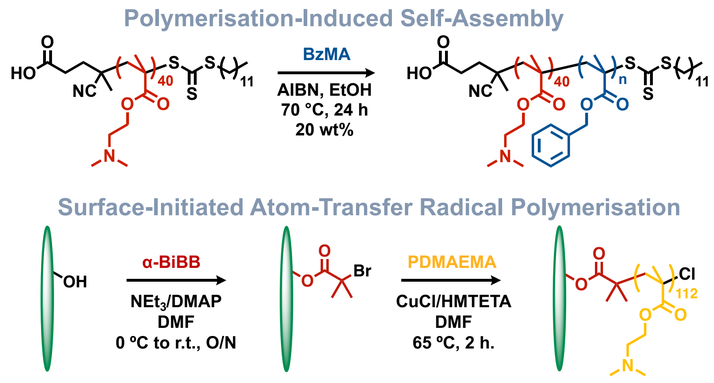
[1] Key Centre for Polymers and Colloids (KCPC), School of Chemistry, The University of Sydney, Sydney 2006, NSW (Australia)
[2] Solid State Chemistry Group, School of Chemistry, The University of Sydney, Sydney 2006, NSW (Australia)
[3] Sydney Nano Institute, The University of Sydney, Sydney 2006, NSW (Australia)

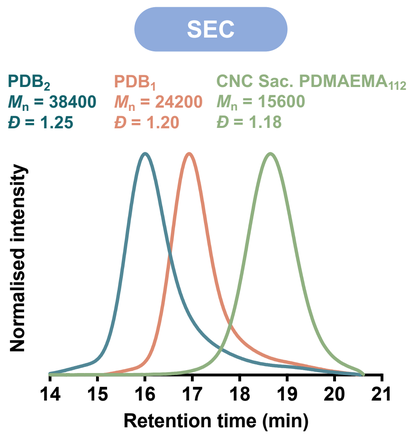
1 Background

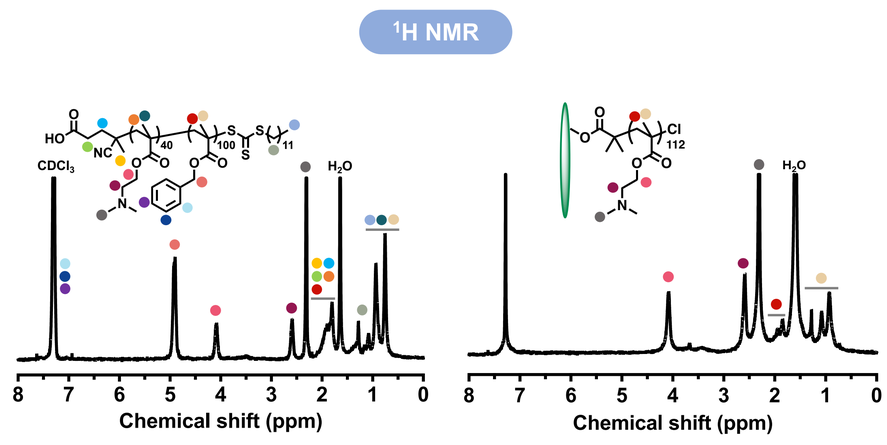
Nanostructured metal oxides possess unique physicochemical properties relative to their bulk analogues, arising from increased specific surface area and shortened ion diffusion pathways. These features make them them highly desirable for applications in catalysis, sensing, and energy storage. Incorporating a carbon framework can further address limitations in conductivity and structural integrity, while also enabling control over porosity and crystallite growth. Herein, we present two modular fabrication methods polymerisation-induced self-assembly (PISA) and cellulose nanocrystals (CNC) as modular synthesis approach to fabricating mesoporous core-carbon-coated anatase (TiO_2/C) nanostructures with tunable morphologies and porosity.



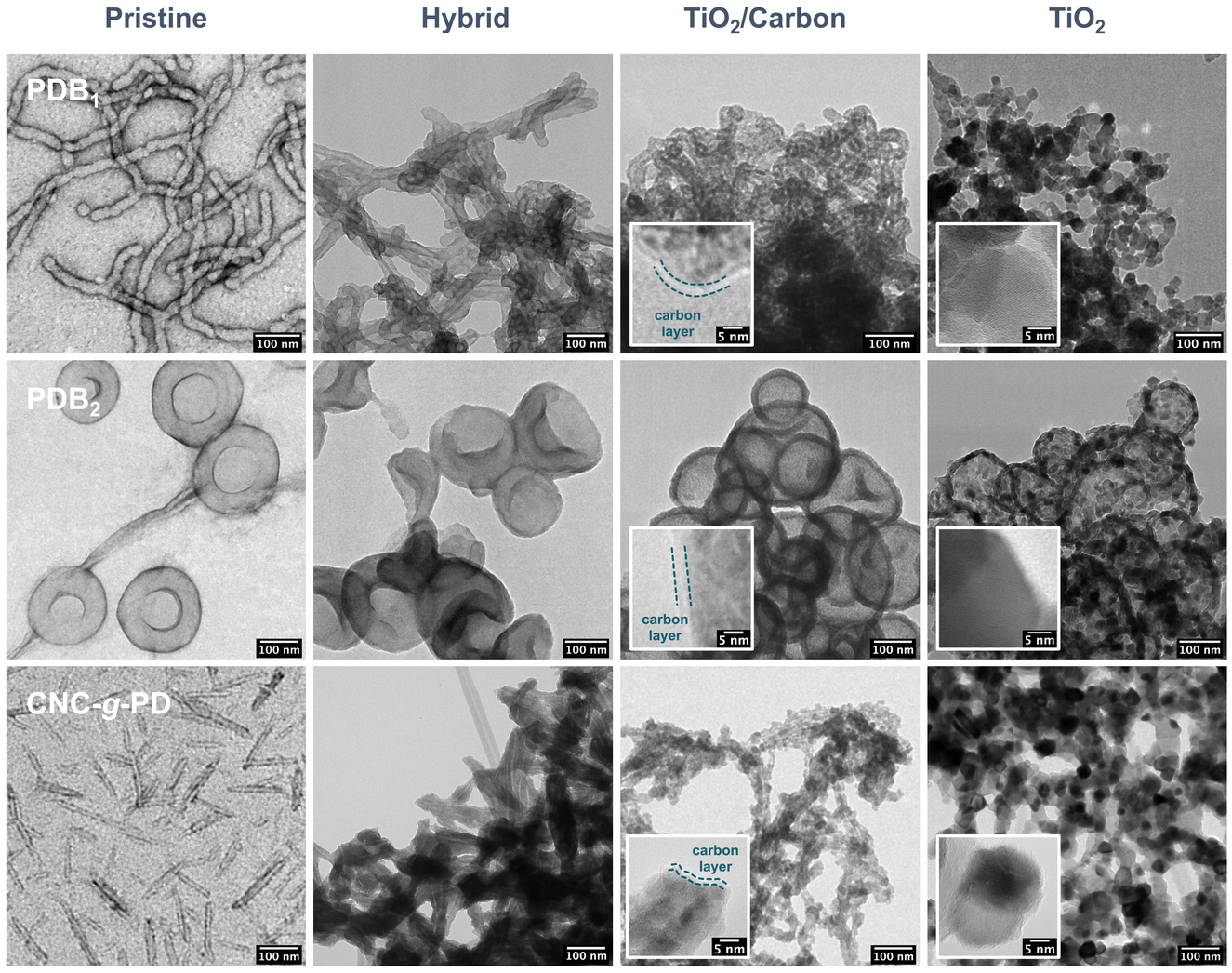
2 Polymer Synthesis and Characterisation

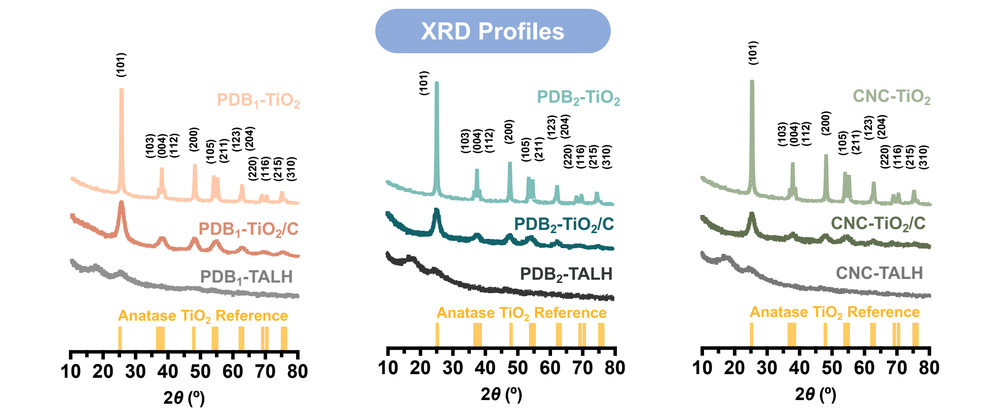


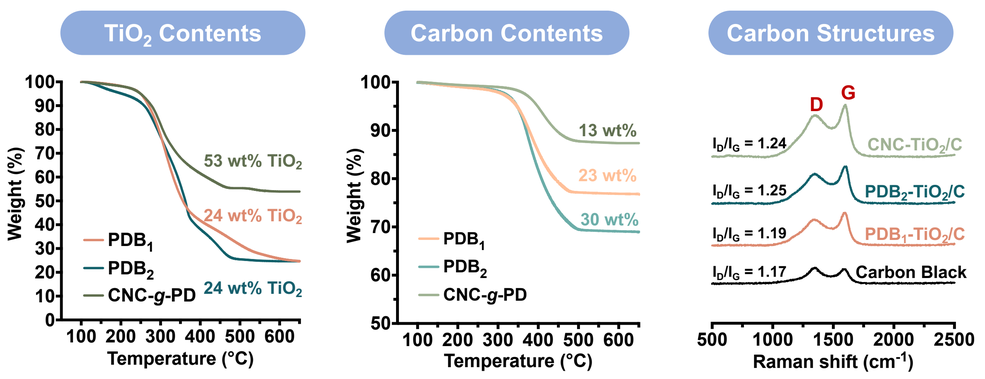


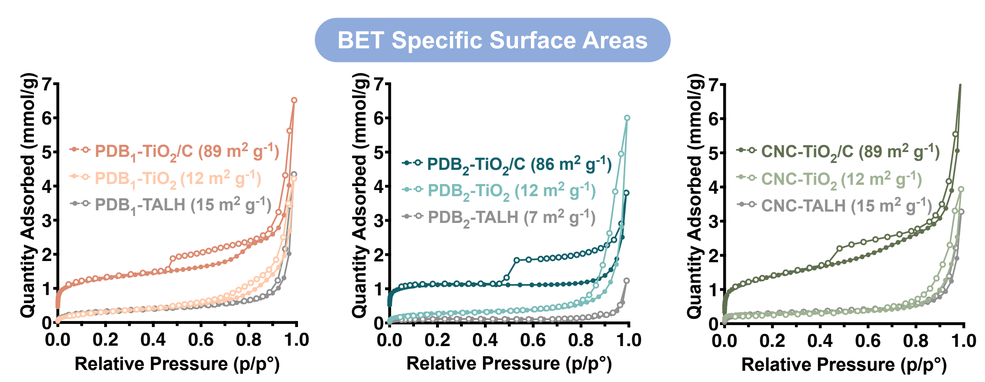


3 Fabrication and Characterisation of TiO_2/Carbon Nanostructures

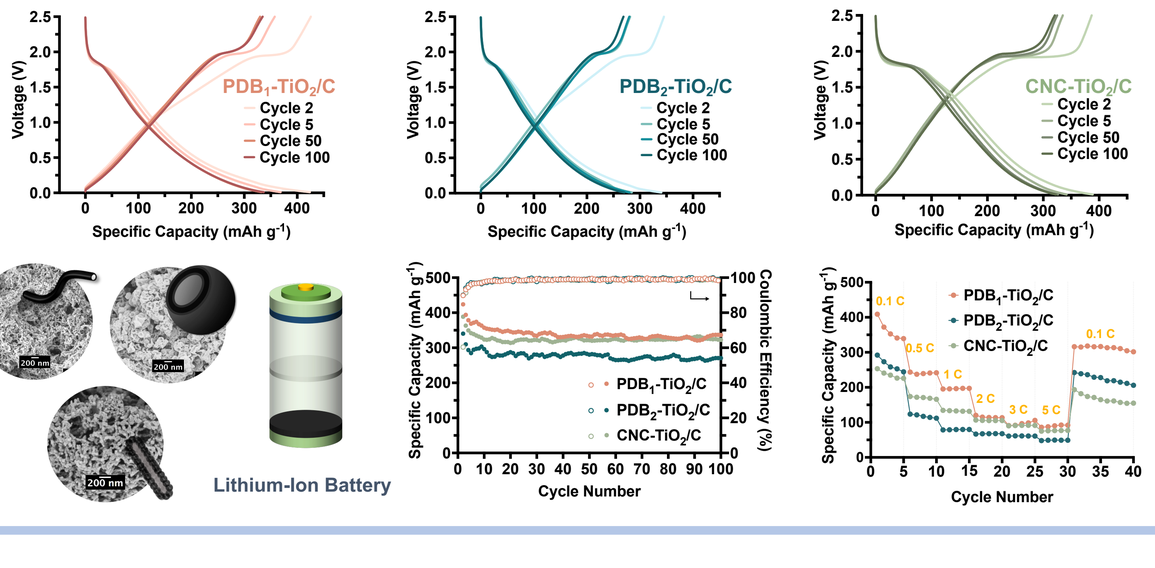








4 Electrochemical Performance As Anode Components



4 Conclusions

We present two templating strategies: PISA block copolymer self-assemblies and CNC-based polymer brush nanoreactors, for the synthesis of mesoporous, carbon-coated anatase TiO_2 nanostructures. Both methods allow for precise control over morphology and crystallite size (<5 nm), while simultaneously introducing a porous carbon framework during pyrolysis. The resulting TiO_2/C nanomaterials exhibit high specific surface areas (up to 111 m²/g) and tunable carbon content (13–30 wt%), with worm-like, vesicular, and tubular architectures. These platforms offer versatile routes to carbon-coated metal oxide nanocomposites with tailorable physicochemical properties for broader applications beyond energy storage.

Markus Müllner: markus.muellner@sydney.edu.au
Yen Theng (Alicia) Cheng: yen.cheng@sydney.edu.au
Group Website: www.polymernanostructures.com

Australian Government
Australian Research Council

1) Cheng, Y. T.; Xia, Q.; Liu, H.; Solomon, M.; Brisson E. R. L.; Blackman L. D.; Ling C. D.; Müllner, M. *ACS Appl. Mater. Interfaces* **2023**, 15 (9), 12261–12272.
2) Cheng, Y. T.; Xia, Q.; Liu, H.; Solomon, M.; Ling C. D.; Müllner, M. *RSC Polym. Chem.* **2023**, 14 (18), 2181–2189.