**Synthesis of tunable and selectively degradable bis-phenol polymers**

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**Research Project** - This project will focus on the development of new tunable and selectively degradable bis-phenol-based polymers. Plastics that use bis-phenol monomers (i.e. BPA) are ubiquitous; for example, they are common building blocks used in polycarbonates and epoxy resins. This has led them to be some of the most widely manufactured industrial plastics (the amount of BPA produced each year by 2023 is estimated to be 7,348 thousand tons)[1] and has seen them find use in everything from water bottles to bicycle helmets to rocket casings.[2]

Despite their ubiquity, bis-phenol-based polymers have several drawbacks that have seen them become shunned for certain applications. BPA has been found to be an endocrine disruptor and there is a drive to remove it from products such as water bottles and food containers.[3] To tackle this problem new bis-phenolic monomers with varying properties are required. In addition, it has already been shown that modification of BPA can have significant impact on its properties; for example, polymerization of tetrabromo-BPA yields a highly heat-resistant polymer.[4] Therefore, the expansion of the bis-phenol monomer library is an exciting opportunity to find new applications and solve current problems.

Access to selectively modified bis-phenol monomers has been a longstanding stumbling block, especially given the identical electronic nature of the monomer’s two phenolic rings. In 2020 the Cobb group published on the selective modification of bis-phenol systems and the regioselective electrophilic substitution of BPA.[5] This approach utilised a tetrafluoropyridyl protecting group to allow regioselective modification of bis-phenols with multiple electrophiles in a high-yielding and selective manner. This means that for the first time, it is now possible to both access these types of monomers but also be able to produce them on large enough scales to be viable for polymer synthesis. This project will exploit this methodology to access highly and selectively elaborated bis-phenolic monomers and produce novel polymers with tunable properties.

**Training** -The student will gain extensive training in small molecule synthesis and methodology development delivered by SLC. The student will gain experience through novel monomer library generation and through monomer derivatisation and elaboration. Work in this area will be further support by a 3-month research placement within Professor Petr Beier (Prague). Professor Beier is a world recognized expert in synthetic fluorine chemistry and specifically in the preparation of SF5 containing aromatics. In the Beier group the student will prepare a series of novel fluorinated aromatic monomers (e.g. SF5 containing BPA) and gain valuable experience in the handling and use of bespoke fluorinating agents like F2.

The student will also gain expertise in synthetic polymer chemistry delivered by CSM. The student will characterise both synthetic polymers and small molecules, using a range of techniques such as NMR spectroscopy, mass spectrometry including MALDI-TOF, high-performance liquid chromatography, dynamic light scattering, thermogravimetric analysis and size-exclusion chromatography, giving them advanced training in analysis. The combination of these areas will give the student a research background with broad applicability in both academic and industrially relevant chemistries

**References**

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[4] D. Yoffe, R. Frim, S. D. Ukeles, M. J. Dagani, H. J. Barda, T. J. Benya, D. C. Sanders, in *Ullmann's Encyclopedia of Industrial Chemistry*, pp. 1-31.

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