SYNTHESIS AND APPLICATIONS OF STABLE ORGANIC RADICALS

Research Question: Can novel Blatter Radical derivatives possess similar properties and potential applications as the existing few?

Typically, open-shell compounds (such as radicals) are highly reactive and result in closed-shell compounds. Blatter radicals, however, are air, moisture and thermally stable due to the extensive delocalization of spin density (arene and endocyclic nitrogen atoms).[1]

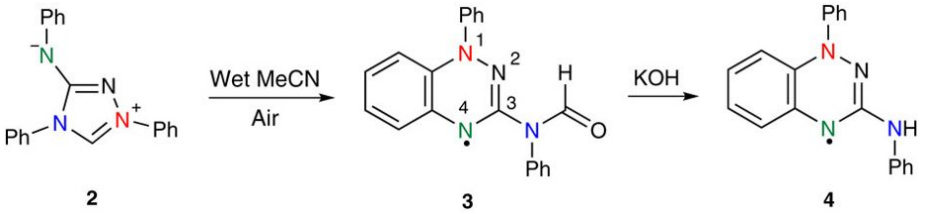

Figure 1. Blatter's radical **1** and the conversion of Nitron **2** into stable radicals **3** and **4**.

Although unexplored since the early report by Blatter in 1968, there has been substantial recent interest in this radical and derivatives due to their possible applications as building blocks in magnetic materials, polymerization initiators and as ligands in novel radical-metal complexes.[2] Additionally, related benzotriazines and N-oxide derivatives have seen application in medicinal chemistry, including as anti-cancer drugs, where benzotrazinyl radicals have been proposed as potential DNA-damaging species.

Despite the broad range of potential applications, the synthesis of these radicals is not straightforward and synthetic approaches have been limited. The O'Donoghue group has recently reported a simple, inexpensive synthetic route from Nitron '**2**' to novel, bench-stable 'Blatter radicals'.[3] Radicals '**3**' and '**4**' could be modified to make functional materials and become incorporated into larger molecules for structure-property studies through exploitation of the protruding groups with on N.

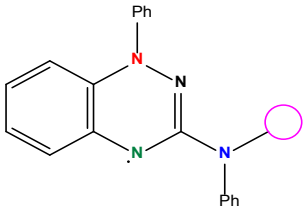

Figure 2. The desired modification of **3** for the first summer, where the circle represents different alkyl chains.

Objectives of the project include:

- Mechanistic investigations to identify how the novel transformation from '**2**' to '**3**'/'**4**' occurred
- Attempts at accessing a broader range of Blatter radicals by changing functional groups through N-alkylation, acylation, reductive amination and cross-coupling radicals '**3**' and '**4**'
- Attempts at accessing a broader range of Blatter radicals by alternatively changing the heteroatoms (N) into S,P or O

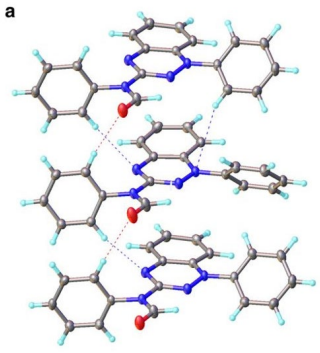

Figure 3. X-ray crystal structure of **3** showing hydrogen bonds between molecules. Manipulation of hydrogen bonding may provide a means for controlling bulk magnetic behavior.

Alkylation is one of the main achievable goals for the first summer, making it the starting point of the summer project. Ideally, the reaction should take place on N of **3**/**4**, but this is not certain. This procedure will also enable further understanding of the radicals and is mechanistic, as nucleophilic sites of the molecule are identified.

Depending on the findings of the first summer, more challenging synthetic topics will be investigated, by carrying out reactions such as reductive amination and cross-coupling or changing the heteroatom (N, which would be particularly difficult).

As this is an underdeveloped research line, more investigations carried out on these and novel radicals lead to a larger knowledge database and in the long term, implementation into reality.

References:

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2. I. S. Morgan, A. Peuronen, M. M. Hänninen, R. W. Reed, R. Clérac, and H. M. Tuononen, "*1-Phenyl-3-(pyrid-2-yl)benzo[e][1,2,4]triazinyl: The First "Blatter Radical" for Coordination Chemistry",* Inorg. Chem. 2014, 53, 1, 33-35
3. J. A. Grant, Z. Lu, D. E. Tucker, B. M. Hockin, D. S. Yufit, M. A. Fox, R. Kataky, V. Chechik & A. C. O'Donoghue, "New Blatter-type radicals from a bench-stable carbene", *Nature Communications*, 2017, DOI: 10.1038/ncomms15088