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COMMUNICATION

Rhodium-Catalysed Enantioselective Synthesis of 4-Arylchroman-2-ones

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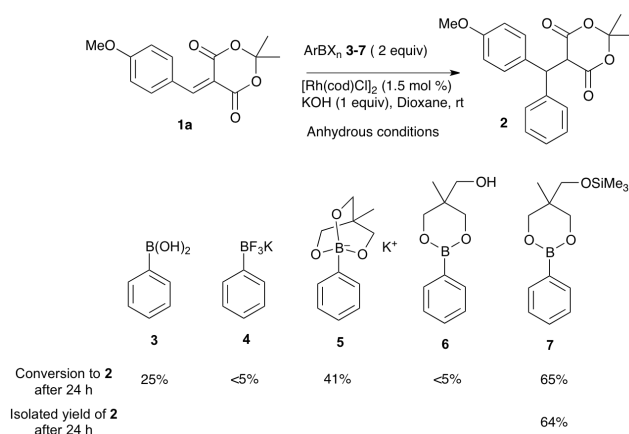
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The rhodium-catalysed enantioselective 1,4-addition of organoboron reagents to arylidene Meldrum's acids as acceptors, allows convenient access to 4-arylchroman-2-ones with good to excellent levels of enantioselectivity. The use of silyl-protected dioxaborinanes as donors was found to be advantageous to achieving good yields of product under anhydrous conditions.

The enantioselective construction of C-C bonds using the rhodium-catalysed 1,4-addition of organometallics is established as an important tool for organic synthesis.¹ For the addition of aryl and alkenylboronic acids, the reaction is routinely carried out in aqueous solvents and can afford excellent enantioselectivities across a wide-range of alkene acceptors. In the majority of applications, boronic acids are the coupling partners of choice for conjugate addition reactions. However, there can be issues with purification and manipulation. Often, an excess of reagent has to be used due to competing protodeboronation processes and by competing formation of trimeric cyclic anhydrides (boroxines) in solution, leading to difficulties in being able to accurately measure reaction stoichiometry.² A number of elegant solutions to this problem have been presented involving the use of preformed boronate reagents that can be isolated and stored prior to use including tris(hydroxy)borates³, lithium trimethoxyboronate species⁴, trifluoroborate salts⁵ (such as **4**) and *N*-methyliminodiacetic acid (MIDA) boronates.⁶ An important addition to this range of donors are the cyclic triolborates **5** synthesised by Miyaura.⁷ These boronate reagents are reported to be stable in air and water and more soluble in organic solvents than potassium trifluoroborates. In this paper we describe the utility of silyl-protected dioxaborinanes in rhodium-catalysed 1,4-addition reactions under anhydrous conditions. This allows the enantioselective addition to arylidene Meldrum's acid derivatives and a subsequent asymmetric synthesis of 4-arylchroman-2-ones. Fillion and co-workers have shown that arylidene Meldrum's acid derivatives such as **1a** are useful substrates for the rhodium-catalysed 1,4-addition of organozinc⁸ and organotin⁹ donors generating a range of products with significant scope for further diversification. The lack of literature reports for the addition of organoboron reagents reflects a greater challenge due to the sterically-hindered nature of the trisubstituted alkene and the sensitivity of the malonate functionality in the product to attack by nucleophiles (e.g. water).¹⁰ Indeed, our initial investigation

into the rhodium-catalysed addition of phenylboronic acid **3** to the 4-methoxyphenyl arylidene Meldrum's acid derivative **1a** in dioxane at room temperature afforded low conversion to product **2**. The anhydrous conditions and low temperature proved detrimental to the application of potassium trifluoroborate salt **4** and hydroxymethyl dioxaborinane **6** (Scheme 1).¹¹



Scheme 1. The addition of arylboron reagents to arylidene Meldrum's acids

Pleasingly, the cyclic triolborate **5** and the silyl-protected dioxaborinane **7** gave the desired product **2** with no traces of decomposition products. The superior conversions and good isolated yield obtained with **7** prompted further investigation of this novel organoboron reagent. The silyl-protected dioxaborinanes are readily prepared in high yield by heating an arylboronic acid with 2-(hydroxymethyl)-2-methylpropane-1,3-diol under Dean-Stark conditions followed by treatment with chlorotrimethylsilane in the presence of triethylamine (See Supporting Information for full details). The arylboron products are easily purified by flash chromatography and can be stored on the bench for several months with no evidence of decomposition. With a range of silyl-protected dioxaborinane reagents in hand, the scope of the rhodium-catalysed addition to arylidene Meldrum's acid acceptors was explored (Scheme 2).

Employing the optimised set of reaction conditions, the isolated yields were consistently good for arylidene Meldrum's acid

