

Potassium Benzene-1,3,5-triyltris(ethynethiolate): A New Core Reagent for Dendrimer Synthesis

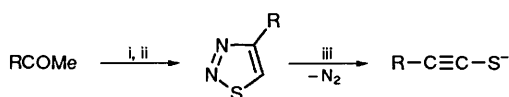
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The title compound **3** is readily available from 1,3,5-triacetylbenzene in a three-step procedure and is an efficient trifunctional core reagent for the synthesis of dendrimers.

The field of cascade molecules (dendrimers) has expanded rapidly since the pioneering work of Vögtle, Tomalia and Newkome.¹ Two synthetic strategies have been developed during the years, known as the divergent and convergent approaches. The divergent approach¹ starts with a multi-functional initiator core on which the branches (generations) are grown by repetitive steps, while in the convergent approach² small building blocks (wedges or dendrons) are first prepared and then attached to a central core. The selection of the reactive core is of great importance since it determines the size, shape, multiplicity and specific functions of the dendrimer. In most cases the reactive functions at the core template are amine, hydroxyl or activated carboxyl (such as acyl chloride). We now report a new trifunctional reagent which can be used as a core in dendrimer synthesis.

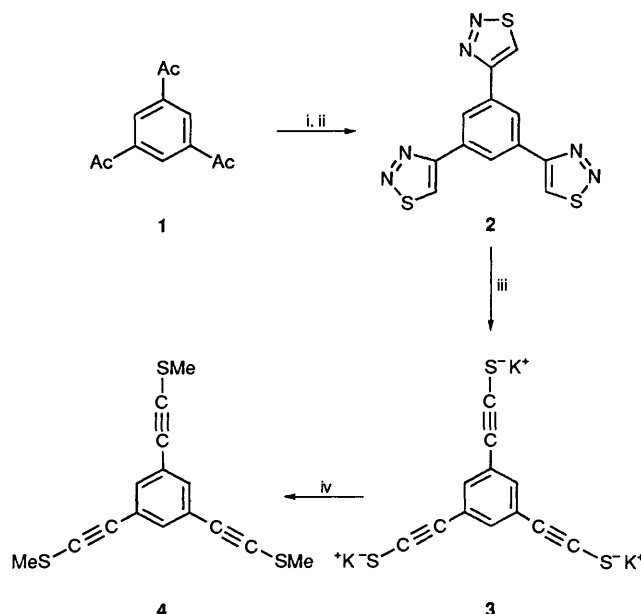
Our approach is based on the knowledge that alkynethiolates are powerful reagents in organic synthesis;³ they are sterically unhindered and much more reactive than hydroxyl or amine functions in nucleophilic displacements. An elegant method for their synthesis is the base-induced ring cleavage of 4-substituted 1,2,3-thiadiazoles,⁴ which themselves are easily accessible from acetyl compounds by the Hurd and Mori method⁵ (Scheme 1).



Scheme 1 Reagents: i, EtO₂C-NHNH₂; ii, SOCl₂; iii, Base

We have extended this principle with success to multi-functional compounds such as biacetyl, 4,4'-diacetylbiphenyl and 1,3,5-triacetylbenzene **1**. In particular, when the latter was treated successively with ethyl carbazate and thionyl chloride, 1,3,5-tris(1,2,3-thiadiazol-4-yl)benzene **2** was obtained in 95% overall yield (m.p. > 200 °C). Although this product is insoluble in most organic solvents, it decomposed smoothly when a suspension of it in dry tetrahydrofuran was treated with potassium *tert*-butoxide at 0 °C; the resulting trithiolate **3** was characterized as the trimethyl derivative (59%, oil). Care should be taken to work under anhydrous conditions to avoid the proton-catalysed dimerization of the alkynethiolate.⁶

In view of the facile synthesis and high reactivity of the trithiolate **3**, it constitutes a suitable core template for dendrimer synthesis. For instance, the benzylic bromide **5** combined readily with the reagent **3** at room temperature to give the first-generation dendrimer **6** as a yellow oil in 38% yield after chromatographic purification. It showed a molecular ion peak at *m/z* 1153 in the FAB mass spectrum with the expected isotope distribution, and the symmetrical structure was confirmed by ¹³C NMR spectroscopic analysis (see Experimental section). Similarly, the trithiolate **3** coupled with Fréchet's dendron² **7** to furnish the second-generation



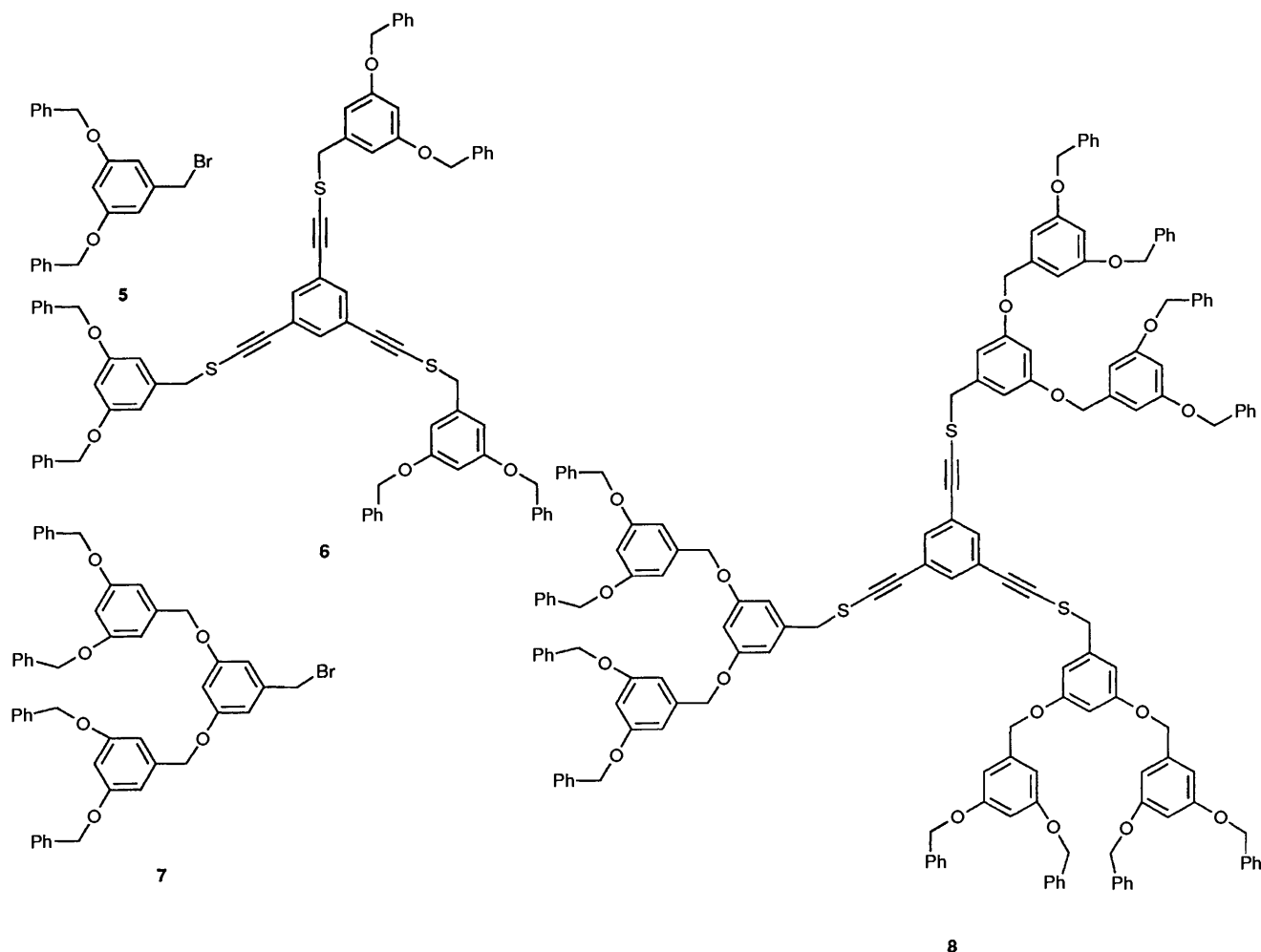
Scheme 2 Reagents: i, EtO₂C-NHNH₂; ii, SOCl₂; iii, Bu^tOK/THF; iv, MeI

dendrimer **8** (mol wt 2427), isolated as a glass in 60% yield and fully characterized by ¹H and ¹³C NMR analysis.

Experimental

Typical Procedure.—A solution of 1,3,5-triacetylbenzene **1** (10.2 g, 50 mmol) and ethyl carbazate (15.6 g, 150 mmol) in toluene (100 cm³) was subjected to azeotropic distillation in a Dean-Stark apparatus to remove the water formed by condensation. After this, the solvent was replaced by thionyl chloride (200 cm³) at 0 °C and the reaction mixture was stirred for 24 h. The precipitated compound **2** was filtered off, washed with diethyl ether and dried (15.7 g, 95%), m.p. > 200 °C; *m/z* 330 (M⁺, 14%), 302 (M⁺ - N₂, 77) and 246 (M⁺ - 3N₂, 100).

Compound **2** (495 mg, 1.5 mmol) was suspended in dry tetrahydrofuran (50 cm³) under a nitrogen atmosphere and treated dropwise at 0 °C with 3.3 equiv. of potassium *tert*-butoxide (555 mg) dissolved in tetrahydrofuran (50 cm³). After the mixture had been stirred for 6 h at 0 °C, a solution of the bromide **5** (2.30 g, 6 mmol) in dry tetrahydrofuran (50 cm³) was added dropwise to it and the whole was stirred overnight. The reaction mixture was then diluted with water (100 cm³) and extracted with chloroform (3 × 150 cm³). The combined extracts were washed with water (300 cm³), dried (MgSO₄) and evaporated. The crude product was chromatographed on silica gel with hexane-chloroform (7:5) as the eluent to give the dendrimer **6** (657 mg, 38%) as a yellow oil; *v*_{max}(neat)/cm⁻¹



2156s ($C\equiv C$) and 1596s; δ_H ($CDCl_3$, 400 MHz) 3.83 (6 H, s, CH_2S), 4.96 (12 H, s, CH_2O), 6.52 (3 H, t), 6.57 (6 H, d), 7.23 (3 H, s) and 7.25–7.37 (30 H, m); δ_C ($CDCl_3$) 40.7 (CH_2S), 70.2 (CH_2O), 81.4 and 93.4 ($S-C\equiv C$), 101.8, 108.3, 138.6 and 160.2 (ArO), 124.2 and 133.1 (central Ar), 127.6, 128.1, 128.7 and 136.8 (Ph); m/z (FAB) 1153 (M^+ , 0.9%) and 91 ($PhCH_2^+$, 100).

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