

THE REACTION OF DIETHYL AZULENE-1,3-DICARBOXYLATE WITH GRIGNARD REAGENTS

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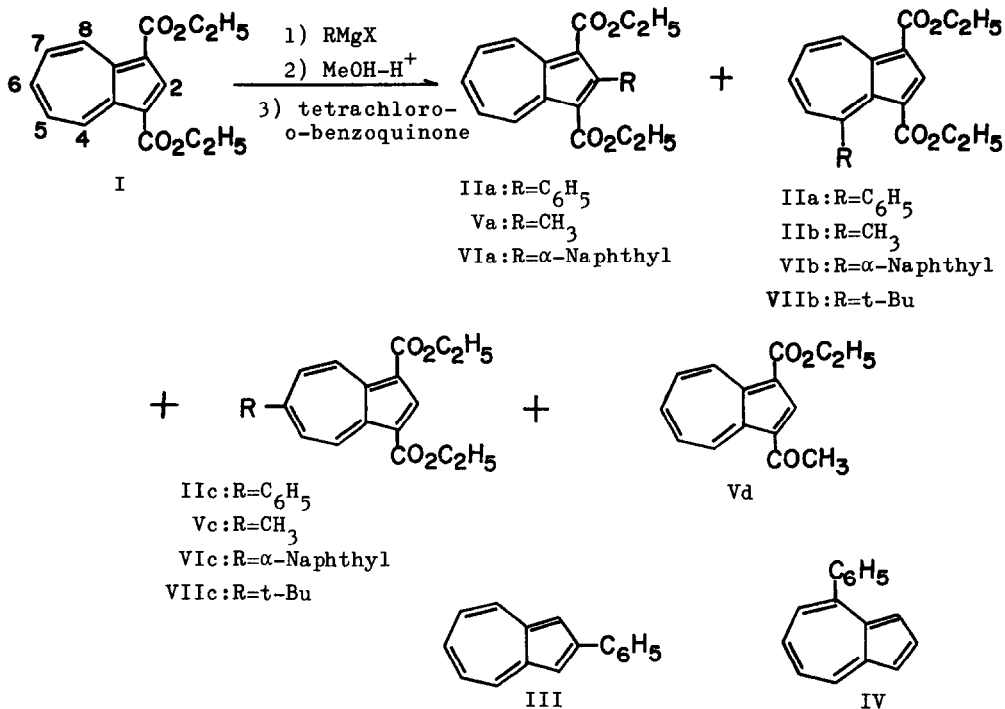
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It has been reported that the reaction of halogenoazulenes with some nucleophilic reagents gave the corresponding substitution products by replacement of the halogeno substituents with the reagents (1, 2, 3). However, no report has been appeared on the reaction of azulenes possessing no halogeno substituent with nucleophilic reagents, with the exception of the observation that organolithium compounds added to azulenes at the 4-position (4). We now wish to report that diethyl azulene-1,3-dicarboxylate (I) easily reacted with Grignard reagents, giving dihydroazulene-type addition products, from which was obtained azulene derivatives by dehydrogenation.

The treatment of diethyl azulene-1,3-dicarboxylate (I) (5) with 2.5 molar equivalents of phenylmagnesium bromide in ether at room temperature gave an oily mixture of dihydroazulene-type addition products (6). Dehydrogenation of this mixture with tetrachloro-o-benzoquinone yielded three isomeric diethyl phenylazulene-1,3-dicarboxylates (IIa, IIb and IIc), which were separated by chromatography on alumina column with benzene. The first effluent gave IIc as red prisms, mp 149~150°C, in a 2% yield, which was identified with diethyl 6-phenylazulene-1,3-dicarboxylate (7). The second effluent gave IIa as red prisms, mp 103~104.5°C, $C_{22}H_{20}O_4$, in a 10% yield, and the third effluent gave IIb as violet needles, mp 124~125°C, $C_{22}H_{20}O_4$, in a 70% yield. On alkaline hydrolysis, followed by decarboxylation upon heating at about 260°C, IIa and IIb gave 2-phenylazulene (III) (8, 9) and 4-phenylazulene (IV) (4), respectively. On the basis of this chemical evidence and the spectral data shown in Tables 1 and 2, IIa

and IIb were assigned the structures of diethyl 2-phenyl- and diethyl 4-phenyl-azulene-1,3-dicarboxylate, respectively.



In a similar manner as with phenylmagnesium bromide, the reaction of I with some other Grignard reagents, such as methyl, α-naphthyl and t-butyl Grignard reagents, gave the corresponding 2-, 4- and 6-substituted diethyl azulene-1,3-dicarboxylates (Va,b,c, VIa,b,c, and VIIb,c) (10), respectively. The yields of the azulene derivatives are listed in Table 3. No 2-substituted azulene was obtained in the reaction with t-butylmagnesium bromide. Further, in the case of the reaction with methylmagnesium iodide, a product (Vd) (10), which should be formed by attack of the reagent at the ester group, was obtained in addition to the substitution products.

On consideration of the structures of the azulene derivatives obtained here, it became clear that the attack of Grignard reagents occurred at the 2-, 4- and 6-positions of diethyl azulene-1,3-dicarboxylate (I). Moreover, the relative yields of the azulene derivatives indicate that bulkiness of the reagents affect

Table 1. The Spectral Data for the Azulene Derivatives

compounds	ir (KBr) $\nu_{C=O}$ cm^{-1}	uv and visible absorption maxima (cyclohexane) nm (log ϵ)
IIa	1675	235 (4.55), 269 (4.43), 305 (4.65), 310 (4.58), 345 (3.97), 365 (3.93), 520 (2.77), 540 (2.76)
IIb	1715, 1686	273 (4.45), 265 (4.42), 295 (4.43), 308 (4.46), 340 (3.99), 377 (3.92), 550 (2.97)
IIc	1681	272 (4.35), 277 (4.36), 327 (4.72), 507 (2.88), 542 (2.75)

Table 2. The nmr Data for the Azulene Derivatives at 60 MHz ($CDCl_3$)

compounds	δ ppm (intensity, pattern, coupling constant Hz, assignment)	
	aromatic protons	protons of OC_2H_5
IIa	7.50 (5H, bs, phenyl), 7.6~8.0 (3H, m, H-5,6,7), 9.81 (2H, bd, 10.0, H-4,8)	0.93 (6H, t, 7.0), 4.18 (4H, q, 7.0)
IIb	7.4~8.0 (8H, m, phenyl, H-5,6,7) 8.72 (1H, s, H-2), 9.97 (1H, bd, 10.0, H-8)	1.08 (3H, t, 7.0), 1.45 (3H, t, 7.0), 3.70 (2H, q, 7.0), 4.48 (2H, q, 7.0)
IIc	7.4~7.8 (5H, m, phenyl), 8.16 (2H, d, 12.0, H-5,7), 9.13 (1H, s, H-2), 9.87 (2H, d, 12.0, H-4,8)	1.48 (6H, t, 7.3), 4.58 (4H, q, 7.3)

Table 3. The Yields of the Azulene Derivatives in the Reaction of Diethyl Azulene-1,3-dicarboxylate (I) with Grignard Reagents

reagents	products and yields (%)						
	2-substituted azulenes		4-substituted azulenes		6-substituted azulenes		others
CH_3MgI	Va	15	Vb	5	Vc	1	Vd 3
C_6H_5MgBr	IIa	10	IIb	70	IIc	2	-----
$\alpha-C_{10}H_7MgBr$	VIa	6	VIb	45	VIc	7	-----
$t-C_4H_9MgBr$	-----		VIIb	1	VIIc	23	-----

the positions of the azulene nucleus attacked, that is, less bulky methyl Grignard reagent gave mainly 2-substituted azulenes (Va), while more bulky *t*-butyl Grignard reagent gave mainly 6-substituted azulenes (VIIc). Further, phenyl and α -naphthyl Grignard reagents with a medium size of bulkiness gave mainly 4-substituted azulenes. These facts suggest that Grignard reagents have a tendency to react with diethyl azulene-1,3-dicarboxylate (I) at the positions in order of 2 > 4 > 6, while the steric hindrance may be greater at the positions in order of 2 > 4 > 6. As has been described above, the 4-phenylazulene derivative (IIb) was obtained in a good yield by the reaction of I with phenylmagnesium bromide. This reaction is thought, therefore, to be a favorable method for synthesizing 4-phenylazulene (IV).

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