

REACTION OF α, α' -DIBROMO KETONES WITH IRON CARBONYLS IN THE PRESENCE OF FIVE-MEMBERED HETEROCYCLES¹

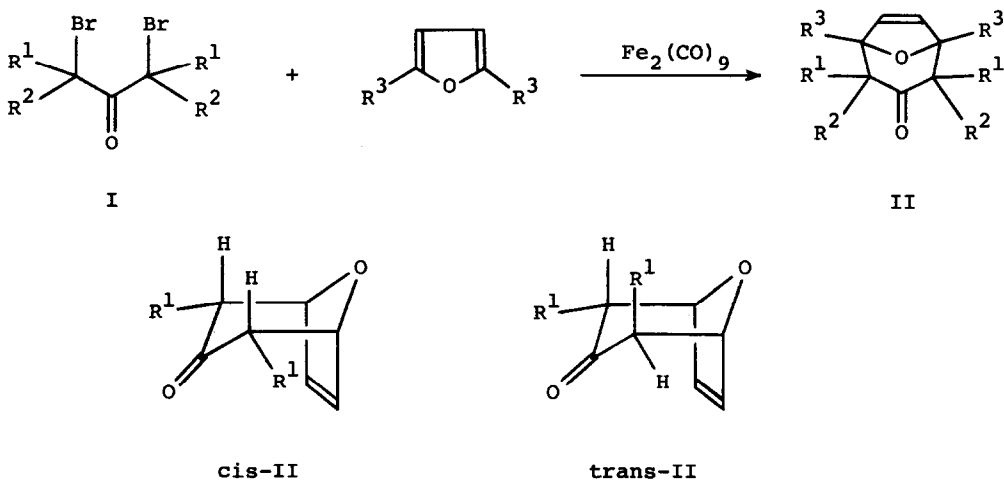
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The dehalogenation of α, α' -dibromo ketones with iron carbonyls provides a new method for carbon-carbon bond formation.² This paper describes the reaction with certain five-membered heterocyclic compounds.

Furan derivatives serve as an efficient receptor toward the reactive intermediates generated in the reaction of $\text{Fe}_2(\text{CO})_9$ with dibromo ketones. For instance, when a mixture of 2,4-dibromo-2,4-dimethylpentan-3-one (I, $\text{R}^1 = \text{R}^2 = \text{CH}_3$) and $\text{Fe}_2(\text{CO})_9$ (1:1.2 mole ratio) in furan was heated at 40° for 24 hr under a nitrogen atmosphere, the cyclic adduct II ($\text{R}^1 = \text{R}^2 = \text{CH}_3$, $\text{R}^3 = \text{H}$) was obtained in 96% yield. Secondary bromides afforded a mixture of stereoisomeric adducts, cis-II and trans-II, in good yields. Reaction of dibromides derived from cyclic

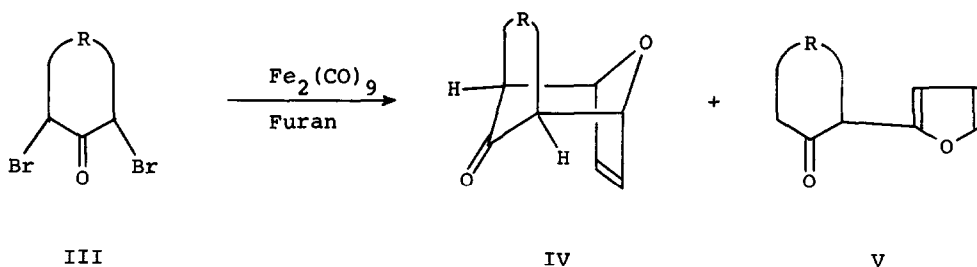


ketones yielded the tricyclic adducts of type IV in addition to some substitution products V. Nmr analysis³ indicates that the methylene chains of IV are axial, whereas the α substituents of cis-II are both equatorial. Some examples of the coupling reaction are given in Table I. α, α' -Dibromoacetone failed to give the furan adduct. Iron pentacarbonyl could be used as the reducing agent, but it was less effective.⁴

Table I. Reaction of Dibromo Ketones with $\text{Fe}_2(\text{CO})_9$ in the Presence of Furans^a

Dibromide	Receptor	Product and % yield ^b (<u>cis</u> : <u>trans</u> ratio ^c)
I ($\text{R}^1 = \text{R}^2 = \text{CH}_3$)	Furan	II, 96 ^c
I ($\text{R}^1 = \text{CH}_3, \text{R}^2 = \text{H}$)	Furan	II, 90 ^c (50:50)
I ($\text{R}^1 = \text{CH}_3, \text{R}^2 = \text{H}$)	2,5-Dimethylfuran ^d	II, ^e 73 ^c (100:0)
I ($\text{R}^1 = (\text{CH}_3)_2\text{CH}, \text{R}^2 = \text{H}$)	Furan	II, ^f 97 ^{c,g} (77:23)
I ($\text{R}^1 = \text{C}_6\text{H}_5, \text{R}^2 = \text{H}$)	Furan	II, ^h 90 (50:50) ⁱ
III ($\text{R} = (\text{CH}_2)_3$)	Furan	IV, ^j 35, ^c and V, 35
III ($\text{R} = (\text{CH}_2)_4$)	Furan	IV, ^k 61, and V, 9
III ($\text{R} = (\text{CH}_2)_5$)	Furan	IV, ^l 60, and V, 23
III ($\text{R} = (\text{CH}_2)_9$)	Furan	IV + <u>trans</u> -II, ^m 52 (14:86), and V, 34

^a Unless otherwise stated, reactions were carried out in refluxing furan (10 ml) for 20—40 hr using 2.0 mmoles of the dibromide and 2.4 mmoles of $\text{Fe}_2(\text{CO})_9$. ^b Isolated yield. ^c Determined by nmr. ^d Reaction was performed in benzene containing 2,5-dimethylfuran (3 equiv to I). ^e Highly subliming. Mp ca. 70° (sealed tube). ^f cis-II, mp 34.5—35.5°. trans-II, mp 34—35°. ^g Yield based on unrecovered starting bromide (76% conversion). ^h cis-II, mp 135—135.5° (lit.³ 134—135°). trans-II, mp 151—152° (lit.³ 152—153°). ⁱ Relative amount of isolated products. ^j Mp 45.5—46°. ^k Mp 50—51°. ^l Mp 50—52°. ^m IV, mp ca. 150° (sealed tube). trans-II ($\text{R}^1\text{R}^2 = (\text{CH}_2)_9$), mp 58—60°.



Reaction of the dibromide I with N-methylpyrrole resulted in the formation of the α - and β -substitution products, VI and VII, respectively. Similar reaction of I with thiophene afforded only the α -substitution product VIII. Several examples are summarized in Table II.

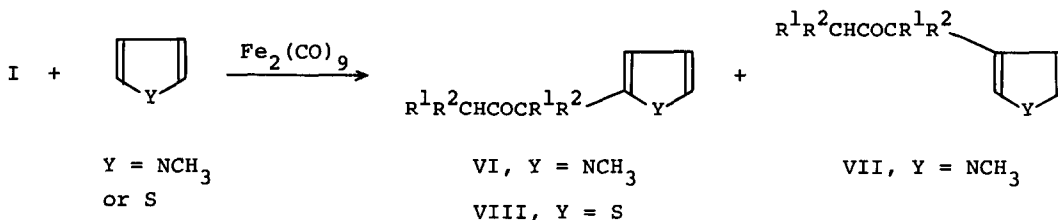
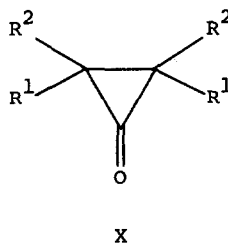
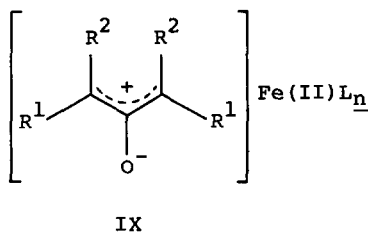


Table II. Reaction of α, α' -Dibromo Ketones with N-Methylpyrrole or Thiophene^a

Dibromide	Receptor	Product and % yield ^b (α : β ratio)
I ($\text{R}^1 = \text{R}^2 = \text{CH}_3$)	<u>N</u> -Methylpyrrole	VI + VII, 82 (38:62)
I ($\text{R}^1 = \text{CH}_3, \text{R}^2 = \text{H}$)	<u>N</u> -Methylpyrrole	VI + VII, 81 (59:41)
I ($\text{R}^1 = (\text{CH}_3)_2\text{CH}, \text{R}^2 = \text{H}$)	<u>N</u> -Methylpyrrole	VI + VII, 77 (80:20)
I ($\text{R}^1 = \text{CH}_3, \text{R}^2 = \text{H}$)	Thiophene	VIII, 37 ^c

^a Reaction was performed in dry benzene (10 ml) using 2.0 mmoles of I, 2.4 mmoles of $\text{Fe}_2(\text{CO})_9$, and 6.0 mmoles of N-methylpyrrole (or thiophene) at 40° for 20–40 hr. All the products gave spectral data consistent with the assigned structure. ^b Determined by nmr. ^c Yield based on the consumed starting bromide (40% conversion).

The foregoing observations can be explained by assuming the intermediacy of zwitterions IX interacting with an iron atom.⁵ The reactivity of the intermediate should be compared with those of the cyclopropanones X, structurally related species. Alkylated cyclopropanones undergo cycloaddition in the absence of metals with furan⁶ or *N*-methylpyrrole,⁷ but not with thiophene⁶ yielding II and the tropinone derivative, respectively. The latter was reported to be thermally labile and readily be converted to the open-chain isomer of type VI. Competition kinetics revealed that the intermediate IX ($R^1 = \text{CH}_3$, $R^2 = \text{H}$; configuration unknown) reacts with cyclopentadiene^{2a} 1.3 times faster than with furan (25° in tetrahydrofuran). The observed selectivity is somewhat lower than that of the cycloaddition of 2,2-dimethylcyclopropanone ($k(\text{cyclopentadiene})/k(\text{furan}) = 2.5\text{--}2.9$).⁶



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