

CHIRAL DISCRIMINATION IN THE REACTIONS OF THE ENOLATE
 $E-[(\eta^5-C_5H_5)Fe(CO)(PPh_3)COCHMe]^-Li^+$ WITH cis AND trans
BUT-2-ENE OXIDES IN THE PRESENCE OF $BF_3 \cdot OEt_2$

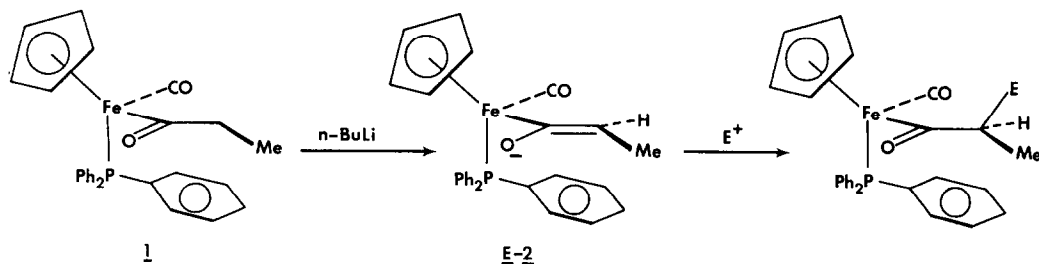
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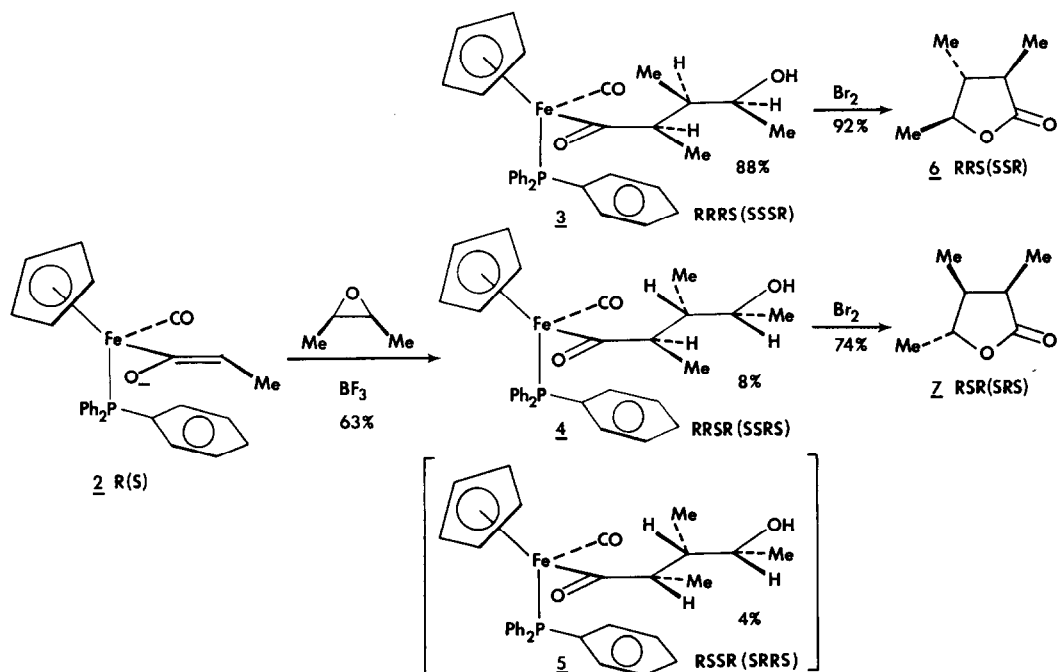
Summary: cis and trans-but-2-ene oxides undergo S_N2 opening with the lithium enolate derived from $[(\eta^5-C_5H_5)Fe(CO)(PPh_3)COCH_2CH_3]$ in the presence of $BF_3 \cdot OEt_2$; preferential opening occurs where the enolate configuration at iron matches that of the epoxide carbon being attacked.

We have recently demonstrated that enolates derived from $[(\eta^5-C_5H_5)Fe(CO)(PPh_3)COCH_2CH_3]$ 1 are efficient chiral propionate enolate equivalents in alkylation¹ and in aldehyde addition reactions.² Addition of n-butyllithium to the racemic iron propanoyl complex 1 generates the E-enolate 2. A variety of electrophiles have been shown to add stereoselectively to enolate 2, the addition occurring from the unhindered face of the enolate in the anti (O^- to CO) conformation.^{1,2,3} We describe here that the lithium enolate 2 opens cis- and trans-but-2-ene oxides in the presence of $BF_3 \cdot OEt_2$ by an S_N2 mechanism. Furthermore chiral discrimination is observed in these reactions with preferential opening occurring where the configurations at iron and the epoxide carbon undergoing S_N2 attack are the same.

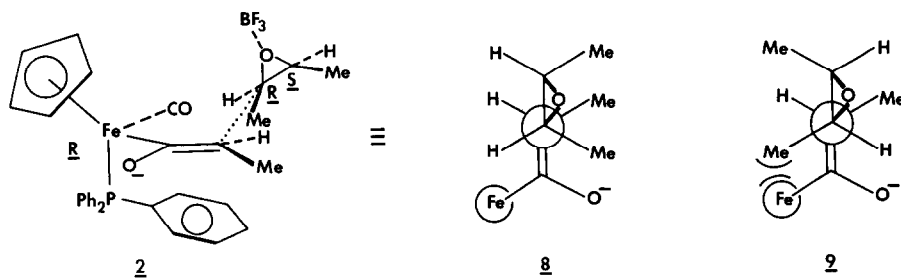


All compounds are racemic but only those with R-configuration at iron are shown for clarity.

Addition of *n*-BuLi to the racemic propanoyl complex 1 at -78°C in tetrahydrofuran generated the *E*-enolate 2. *cis*-But-2-ene oxide (1.1 equiv.) was added to 2 followed immediately by $\text{BF}_3 \cdot \text{OEt}_2$ (1.2 equiv.). The reaction was stirred at -78°C for 6 hrs and then methanol and a small amount of alumina (Grade V) were added. Work-up gave a mixture of only three of the possible eight diastereomeric products 3, 4 and 5 in the ratio 88:8:4. Complexes 3 and 4 could be isolated pure by chromatography on alumina (Grade 1). The major product 3 exhibited an α -methyl doublet at $\delta=0.01$ in the ^1H nmr spectrum clearly indicative of the relative configurations of the iron to C_{α} being RR,SS.⁴ Oxidative decomplexation of 3 gave the known⁵ RRS, SSR lactone 6 thereby establishing the relative configurations of the four chiral centres in 3 as RRRS, SSSR. Similarly for complex 4 the α -methyl doublet at $\delta 0.19$ in the ^1H nmr spectrum and the oxidative decomplexation to the known RSR,SRS lactone 7⁵ established the relative configurations of the four chiral centres in 4 as RRSR,SSRS. The remaining diastereoisomer 5 had a relative configuration of iron to C_{α} of RS,SR and the remaining two centres were assigned tentatively on the basis of an $\text{S}_{\text{N}}2$ opening of the *cis*-epoxide and the generalisation that double stereodifferentiating reactions between unmatched species are less stereoselective than those between matched species.⁶



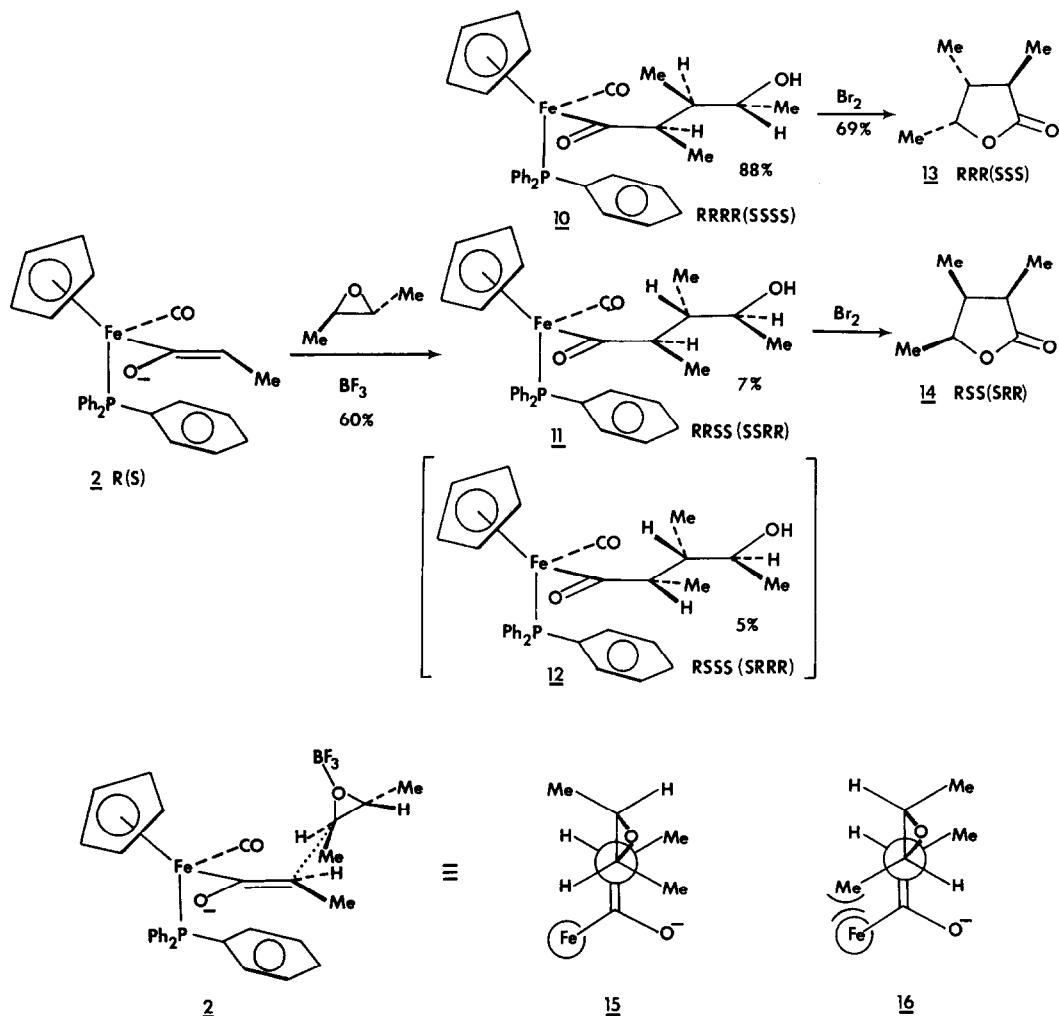
The formation of 3 and 4 is consistent with the expected addition of the epoxide to the unhindered face of the anti enolate 2. The marked preponderance of 3 is indicative of a preferential opening of a given epoxide chiral centre by an enolate having the same configuration i.e. the R-enolate 2 discriminates between the R and S centres in the meso epoxide preferring the former whilst the S-enolate 2 prefers the latter. These observations are consistent with the linear transition state 8 leading to 3 in which the methyl group at the site of reaction on the epoxide avoids the steric interactions with the large iron moiety which are present in transition state 9 leading to 4. In common with other double stereodifferentiating reactions the matched case would be expected to be very stereoselective in contrast to the unmatched case.⁶ On this basis the configurations of the β and γ centres relative to iron in 5 are assigned on the same basis as those in 4.



Subjecting the enolate 2 under the same reaction conditions to trans-but-2-ene oxide again resulted in the formation of three products 10, 11 and 12 in the ratio 88:7:5. The α -methyl doublet at δ -0.02 in the ¹H nmr spectrum and the decomplexation to the known RRR,SSS lactone⁵ 13 established the relative configurations of 10 as RRRR,SSSS. Similarly for 11 the α -methyl doublet at δ 0.19 in the ¹H nmr spectrum and the decomplexation to the known RSS,SRR lactone⁵ 14 established the relative configurations as RRSS,SSRR. In a similar way to that described for complex 5 the relative configurations of 12 were assigned tentatively as RSSS,SRRR.

Once again the formation of 10 and 11 demonstrates the clear preference for addition to the unhindered face of enolate 2. Furthermore the complete lack of crossover products between the reactions of cis- and trans-but-2-ene oxides indicates clean S_N² opening of both epoxides and this lends further credence to the tentative configurational assignments of 5 and 12. As before, the preferential formation of 10 is consistent with transition state 15 being of lower energy than 16. In this case, however, enolate 2 is discriminating between the two enantiomers of the trans-epoxide rather than between the

two ends of a *cis*-epoxide. The R-enolate 2 reacts faster with RR-*trans*-but-2-ene oxide while the S-enolate is matched with the SS-epoxide.



The origins and optimisations of these remarkable chiral discriminating reactions are under investigation as are the extensions of these reactions to other chiral auxiliaries.

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References:

1. G. J. Baird and S.G. Davies, *J.Organometal.Chem.*, 1983, **248**, C1; G.J. Baird, J.A. Bandy, S.G. Davies and K. Prout, *Chem.Comm.*, 1983, 1202.
2. S.G. Davies, I.M. Dordor-Hedgecock and Peter Warner, *Tetrahedron Letters*, 1985, 2125; P.W. Ambler and S.G. Davies, *Tetrahedron Letters*, 1985, 2129.
3. S.G. Davies and J.I. Seeman, *Tetrahedron Letters*, 1984, 1845.
4. S.G. Davies, I.M. Dordor, J.C. Walker and P. Warner, *Tetrahedron Letters*, 1984, 2709.
5. M. Petrizilka, D. Felin and A. Eschenmoser, *Helv.Chim.Acta*, 1973, **56**, 2950.
6. S. Masamune, W. Choy, J.S. Petersen and L.R. Sita, *Angew.Chem.Int.Ed.*, 1985, **24**, 1.

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