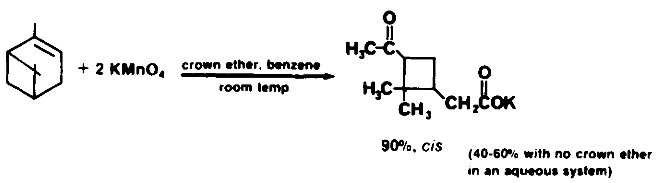
Crown Ethers

How to dissolve alkali metal salts in organic solvents

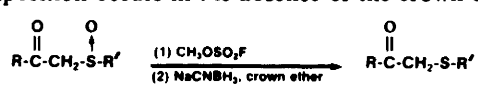
Since the discovery of their remarkable ability to solubilize alkali metal salts in non-polar solvents, crown ethers,[1a,b] a class of macrocyclic polyethers, have found novel application in synthesis. The new crown ether, **18-crown-6**, promises even greater synthetic utility by virtue of its increased complexing ability.[2] For example, in acetonitrile or benzene effective solvation of the potassium ion of potassium fluoride by **18-crown-6** results in a highly reactive fluoride ion ("naked" fluoride).[2] "Naked" fluoride is a potent base and nucleophile,[2] being capable of converting a variety of alkyl, acyl, or activated aryl halides to their respective fluorides in good yields.

$$CH_3(CH_2)_6CH_2Br \xrightarrow[CH_3CN]{KF,\ 18\text{-crown-}6} CH_3(CH_2)_6CH_2F\ (92\%) + CH_3(CH_2)_5CH{=}CH_2\ (8\%)$$

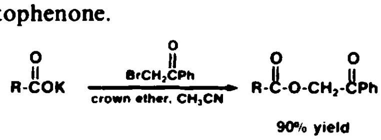
In the presence of **dicyclohexyl-18-crown-6**, potassium permanganate readily dissolves in benzene to form a purple solution ("Purple Benzene")[3] which oxidizes alcohols, olefins, aldehydes and aralkyl hydrocarbons in excellent yield under neutral conditions.



Alkoxysulfonium salts, formed by alkylation of sulfoxides with Magic Methyl® (methyl fluorosulfonate), are readily reduced with sodium cyanoborohydride in the presence of crown ethers[4] to give sulfides in excellent yield. Similarly, β-ketosulfoxides are reduced to β-ketosulfides,[4] whereas extensive decomposition occurs in the absence of the crown ether.



Phenacyl esters which are difficult to obtain in good yield using classical procedures are easily formed by refluxing a benzene or acetonitrile suspension of acyl salt, crown ether and α-bromoacetophenone.



The alkylation of acetoacetic ester enolates gives less O-alkylated product in the presence of a crown ether,[5] especially in weakly polar solvents. **Dicyclohexyl-18-crown-6** markedly changes the rates and stereochemical course[6] of alkoxide-catalyzed carbanion-generating reactions; *e.g.*, the reaction of 5-decyl tosylate with potassium alkoxides[7] produces more *trans* olefin in the presence of **dicyclohexyl-18-crown-6**. Crown ethers also find application in the resolution of α-amino acids[8] and show promise for the preparation of organometallics[9] by catalyzing the reaction between metals and C-halogen or acidic C-H compounds. The potassium hydroxide complex of **dicyclohexyl-18-crown-6** reacts with *o*-dichlorobenzene[10] to give *o*-chloroanisole in 40-50% through a non-benzyne mechanism. Finally, crown ethers may be contrasted with our α- and β-cyclodextrins. While the cyclodextrins have a lipophilic cavity and hydrophilic shell the reverse is true of the crown ethers.[11]

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Home Office:
Aldrich Chemical Co., Inc.
940 W. St. Paul Ave.
Milwaukee, Wisconsin 53233

In Great Britain:
Ralph N. Emanuel Ltd.
264 Water Rd., Wembley, Middx.
HAO 1PY, England

In Continental Europe:
Aldrich-Europe
B-2340 Beerse
Belgium

In Germany:
EGA-Chemie KG
7924 Steinheim am Albuch
Germany