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POTASSIUM FLUORIDE ON CELITE.
A VERSATILE REAGENT FOR C-, N-, O-, AND S-ALKYLATIONS

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Celite coated with potassium fluoride was found to be an effective and economical reagent for hydrogen-bond-assisted reactions. C-, N-, O-, and S-alkylations were conveniently performed in high yields under mild conditions.

Recent reports concerning solid-supported fluorides as reagents to promote various base-catalyzed reactions prompt us to communicate our preliminary results using diatomaceous earth coated with potassium fluoride (KF-Celite) to facilitate alkylation reactions.[1,2]

The utility of alkali metal fluorides in hydrogen-bond-assisted reactions has been recognized in recent investigations by Miller and his coworkers.[3,4] Nucleophilicity of a variety of protic organic compounds in aprotic solvents is greatly enhanced under essentially neutral conditions by forming hydrogen bonds with fluoride anion. Thus, O-, N-, and S-alkylations with alkyl halides have been carried out in high yields.[3] However, low solubilities of alkali fluorides in ordinary solvents hamper their wide applications in organic synthesis. Preformation of solid solvates or the use of a high-boiling solvent such as dimethylformamide has been employed, but they are rather inconvenient. Tetraalkylammonium fluorides are often used in place of alkali fluorides because not only the former is much more soluble but also they can catalyze C-alkylation of β-dicarbonyl compounds effectively and selectively.[2,5] However, they are so expensive and hygroscopic that their substitutes are highly desirable.[1]

Celite 545 (Johns-Manville, 20 g) was mixed with its equal weight of potassium fluoride in 500 ml of water, and the water was removed at 50-60 °C in a rotary evaporator. The Celite obtained (*ca.* 60 g) was then shaken in 100 ml of acetonitrile, filtered, washed with two 50 ml portions of acetonitrile, and dried in a desiccator at room temperature.[6]

Alkylation of a substrate was usually carried out with 1.0-1.5 equiv of an alkyl halide in the presence of *ca.* 5 equiv of KF-Celite in acetonitrile.[7] The mixture was simply shaken or magnetically stirred at room temperature or at an appropriate temperature in the cases of less reactive halides.[8] Work-up was carried out under non-aqueous conditions; addition of ether, filtration, washing with ether, evaporation of the solvent, and distillation or recrystallization. Thus, alkylation of phenol, aniline, piperizine, thiophenol, and even of pentane-2,4-dione and 1,3-diphenylpropane-1,3-dione proceeded smoothly. Selectivity toward C-alkylation was not so extreme as in the cases of tetraalkylammonium

Table 1. Yields of KF-Celite catalyzed reactions

Substrate	Halide	T/°C	t/h	Yield/%[a]
$(CH_3CO)_2CH_2$	MeI	rt[b]	20	100[c] (75)
	EtI	rt	48	54[d]
	n-BuI	70	14	84[e]
	n-BuBr	70	94	78[f]
$(PhCO)_2CH_2$	MeI	rt	48	-- (86)
PhOH	MeI	rt	40	89
	n-BuI	rt	72	43
	n-BuI	60	92	83
	CH_2=$CHCH_2Br$	rt	72	92
	$PhCH_2Br$	60	17	99 (87)
PhSH	MeI	rt	0.5	100
	n-BuCl	rt	20	94
$PhNH_2$[g]	MeI	rt	24	100[h]
	n-BuI	rt	48	47
	n-BuI	rt	137	86[i]
	$PhCH_2Cl$	60	24	-- (74)
$C_5H_{10}NH$[g]	*n*-BuI	rt	2	75

[a] Yields were not optimized. Isolated yields after purification are shown in parentheses, and the others are those determined by GLPC using internal standards. [b] Room temperature. [c] C-Alkylation(99%) and a by-product(1%). [d] C-Alkylation (95%) and a by-product(5%). [e] Mechanically stirred. C-Alkylation(86%) and O-alkylation(14%). [f] C-Alkylation(65%) and O-alkylation(35%). [g] Four moles of a substrate and 5 moles of KF-Celite were used for 1 mole of a halide. Yields are based on the halide used. [h] A mixture of mono and dimethylanilines (1:0.32). [i] A mixture of mono and dibutylanilines (1:0.08).

fluoride-catalyzed reactions.[5] Typical results are shown in Table 1.

As reaction conditions are mild, yields are good in most cases, and work-up is simple, KF-Celite can be considered as an attractive example of inorganic solid-supported reagents.

References and Notes. 1) J. H. Clark, J. Chem. Soc., Chem. Commun., 1978, 789. 2) J. M. Miller, K.-H. So, and J. H. Clark, J. Chem. Soc., Chem. Commun., 1978, 466. 3) J. H. Clark and J. M. Miller, J. Am. Chem. Soc., 99, 498 (1977); J. Chem. Soc., Chem. Commun., 1976, 229; Tetrahedron Lett., 1977, 599. 4) J. H. Clark, H. L. Holland, and J. M. Miller, Tetrahedron Lett., 1976, 3361. 5) J. H. Clark and J. M. Miller, J. Chem. Soc., Perkin Trans. 1, 1977, 1743, 2063; J. Chem. Soc., Chem. Commun., 1977, 64. 6) The KF-Celite thus obtained weighed *ca.* 40 g. The actual quantity of potassium fluoride supported on Celite was not determined accurately. Sometimes the weight of KF-Celite exceeded the sum of those of KF and Celite used, but it is interesting to note that the "wet" KF-Celite was also effective as "dry" one. 7) DMF or THF can also be used as a reaction solvent. 8) Mechanical stirring apparently facilitates the reaction and is recommended in a large scale preparation.

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