

CHROM. 16,588

## Note

### Low-volatility acid catalysts in forced silylation of alcohols and phenols for gas-liquid chromatography

G. W. PEROLD

*Department of Chemistry, University of the Witwatersrand, Johannesburg 2001 (South Africa)*

(Received January 19th, 1984)

Chlorotrimethylsilane (CTMS) is generally used as a catalyst in silylation procedures<sup>1</sup> and its function has been described as that of a proton donor in the case of the new N-trimethylsilyl-2-oxazolidinone (SOA) reagent<sup>2</sup>.

In the forced silylation of hindered alcohols and phenols, elevated temperatures and extended periods of reaction are required for complete silylation, and under such circumstances CTMS aggressively attacks plastic fittings so that all-glass systems are required. We have now found that effective acid catalysis in silylation procedures may be attained by the use of pyridine hydrochloride (Py · HCl) or, even better, *p*-toluenesulphonic acid (TsOH). Plastic fittings remain unaffected up to 100°C and the reagents and by-products are volatile enough to be flushed from the column before the emergence of derivatives of alcohols and phenols of molecular weights around 300.

The above novel and very highly effective silylation reagent (SOA) introduced by Palomo was shown<sup>2</sup> to afford quantitative silylation of (back-hindered) tertiary butanol in the presence of *ca.* 1% of CTMS. We have found SOA very useful in the gas chromatographic (GC) analysis of a range of phenolic alcohols, particularly in the case of phenolic polyhydroxy-lactones of the leucodrin<sup>3</sup> and conocarpin<sup>4</sup> type. The most severely hindered hydroxy function in this series occurs in the case of reflexin<sup>5</sup>, where the tertiary hydroxy group is severely hindered both back and front.

Full conversion to the penta(trimethylsilyl) derivative of reflexin was obtained with SOA in 2 h at 72°C with 0.1 *M* TsOH in either dimethylformamide (DMF) or pyridine (Py) solution. In the case of Py · HCl more than 2 h at 102°C was necessary to obtain full conversion.

The effect of varying concentrations of these two catalysts in these two media is shown by the results in Table I. *p*-Hydroxytoluenesulphonic acid may therefore be generally useful in forced silylation procedures for quantitative GC analysis of hindered alcohols and phenols.

#### EXPERIMENTAL

N-Trimethylsilyl-2-oxazolidinone (SOA) was prepared as reported<sup>2</sup>, b.p. 120-122°C at 7 torr. Pyridine hydrochloride, from pyridine and 10 *M* hydrochloric acid, was dried by azeotropic distillation with benzene<sup>6</sup> and sublimed at *ca.* 150°C at 22 torr.

TABLE I

PERCENTAGE CONVERSION OF REFLEXIN TO PENTA(TRIMETHYLSILYL)REFLEXIN WITH SOA

Results were replicable within  $\pm 3\%$ .

Catalyst molarity	Time (h)	Temp. ( $^{\circ}$ C)	TsOH catalyst		Py · HCl catalyst	
			in Py	in DMF	in Py	in DMF
0.1	2	72	100	100	42	42
0.05	2	72	—	102	—	30
0.033	2	72	86	—	35	—
0.01	2	72	55	—	25	—
0	2	72	—	18	—	—
0.2	3	72	—	100	—	—
0.1	3	72	—	100	—	—
0.033	3	72	—	98	—	—
0.01	3	72	—	81	—	—
0.2	2	102	100	—	84	—
0.1	2	102	102	—	74	—
0.033	2	102	100	—	48	—
0.01	2	102	86	—	25	—

Known mixtures (1 mg) of conocarpin<sup>4</sup> and reflexin<sup>5</sup> in SOA (30  $\mu$ l) and solvent (30  $\mu$ l) containing varying concentrations of catalyst (see Table I), as well as cholesterol (0.30 mg) as a marker (see below), were heated in small conically drawn vials with polythene stoppers, as shown in Table I. Aliquots (1  $\mu$ l) were injected directly onto a column (1.1  $\times$  0.003 m) packed with OV 17 (1% on Anakrom Q) with nitrogen as carrier gas at 24 ml/min, at 222 $^{\circ}$ , programmed at 8 $^{\circ}$ /min, in a Pye Unicam GCD chromatograph with flame ionization detector. The emergent temperatures for the silylated derivatives were 246 $^{\circ}$  for reflexin, 249 $^{\circ}$  for conocarpin, and 258 $^{\circ}$  for the cholesterol marker.

Evaluation of the GC traces was by the heights<sup>7</sup> of the clearly resolved peaks. Separate runs on the pure compounds showed that FID responses were equivalent and linearly proportional<sup>8</sup> for all three silylated derivatives. Replicated results for percentage conversion of reflexin to penta(trimethylsilyl)reflexin were repeatable within  $\pm 3\%$ .

#### ACKNOWLEDGEMENT

Financial support by the Council for Scientific and Industrial Research is gladly acknowledged.

#### REFERENCES

- 1 A. E. Pierce, *Silylation of Organic Compounds*, Pierce Chemical Co., Rockford, IL, 1968, pp. 19 and 23.
- 2 J. M. Aizpurua and C. Palomo, *Bull. Soc. Chim. II*, (1982) 265.
- 3 G. W. Perold and K. G. R. Pachler, *J. Chem. Soc. C*, (1966) 1918.
- 4 P. E. J. Kruger and G. W. Perold, *J. Chem. Soc. C*, (1970) 2127.

- 5 G. W. Perold, A. J. Hodgkinson and A. S. Howard, *J. Chem. Soc. Perkin Trans. I*, (1972) 2450.
- 6 E. E. Gilbert, in M. Fieser and L. Fieser (Editors), *Reagents for Organic Synthesis*, Vol. 2, Wiley-Interscience, New York, 1969, p. 352.
- 7 J. Lebbe, in J. Tranchant (Editor), *Practical Manual of Gas Chromatography*, Elsevier, London, 1969, p. 264.
- 8 A. E. Pierce, *Silylation of Organic Compounds*, Pierce Chemical Co., Rockford, IL, 1968, p. 30.