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PAPER

On the enantioselectivity of aziridination of styrene catalysed by copper triflate and copper-exchanged zeolite Y: consequences of the phase behaviour of enantiomeric mixtures of *N*-arene-sulfonyl-2-phenylaziridines†

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By synthesising *S*-2-phenyl-*N*-(4-nitrophenyl)aziridine from *S*-phenylglycinol, it has been demonstrated that the aziridination of styrene by [*N*-(4-nitrobenzenesulfonyl)imino]phenyliodinane (nosyliminophenyliodinane, PhINNs) in the presence of *S*,*S*-2,2′-isopropylidene-bis(4-phenyl-2-oxazoline), catalysed by copper(II) triflate in CH_3CN solution or heterogeneously by CuHY, has predominantly an *R*-configuration. The enantioselectivity of the aziridination of styrene by [*N*-arenesulfonylimino]-phenyliodinanes catalysed by copper-exchanged zeolite Y (CuHY), in conjunction with a chiral bis-oxazoline ligand, has been re-examined. In the case of PhINNs, it is shown that the product mixture of enantiomeric aziridines, on treatment with hexane, gives rise to a solid phase of low enantiomeric excess (ee) and a solution phase of high ee. Separation of the solid phase and recrystallisation afforded a true racemate (racemic compound), which has been confirmed by X-ray crystallography. The aziridine obtained from the solution phase could be recrystallised to produce the pure enantiomer originally in excess. A consequence of the new findings is that previous reports on the enantioselectivity of copper-catalysed aziridination, both in heterogeneous and homogeneous conditions, should be regarded with caution if the analytical procedure involved HPLC with injection of the enantiomeric mixture in a hexane-rich solvent. Such a method has been used in previous work from this laboratory, but has also been used elsewhere, following the procedure developed by Evans and co-workers when the (homogeneous) copper-catalysed aziridination by PhINTs was first discovered. Evidently, the change of substituent in the benzenesulfonyl group reduces the solubility in hexane, affording a solution phase of enhanced ee.

Introduction

The development of enantioselective organic reactions continues apace, and adaptation of such procedures for commercial applications in the pharmaceutical field, for example, is an important part of the worldwide effort. Following our earlier work on the gas-phase dehydration of 2-butanol in the chirally modified pores of zeolite Y,[1] we developed a heterogeneous version of the Evans copper salt-catalysed aziridination of alkenes by [*N*-(toluene-4-sulfonyl)imino]phenyliodinane (PhINTs) in the presence of non-racemic bis(oxazoline) ligands[2] using copper(II)-exchanged zeolite Y (CuHY). Using PhINTs, the heterogeneous process yielded enantiomeric mixtures of aziridines of comparable ee to Evans' homogeneous procedure.[3] High yields of aziridine could be achieved with CuHY without the use of large excesses of alkene, as had been necessary in homogeneous solution, because of an apparent affinity of the alkene for the pore interior of the zeolite. About the same time, Sodergren *et al.* reported that alteration of the 4-substituent in PhINTs (*e.g.* to NO_2 or OMe) afforded an aziridinating agent that gave higher yields of aziridine in homogeneous reactions without an excess of alkene,[4] and gave greater enantioselectivities in reactions in the presence of *S*,*S*-2,2′-isopropylidene-bis(4-phenyl-2-oxazoline).[5] Under our heterogeneous conditions, the use of the nitro-substituted aziridinating agent [*N*-(4-nitrobenzenesulfonyl)imino]phenyliodinane (nosyliminophenyliodinane, PhINNs) and the same bis(oxazoline) ligand in the reaction with styrene also showed improved yields of *N*-nosyl-2-phenyaziridine and apparent enantioselectivities that were even higher (82%) than had been reported for the homogeneous reaction under otherwise similar conditions (66%).[6–8]

We now report a further examination of the reaction of styrene with PhINNs catalysed by copper(II) triflate and CuHY in the presence of *S*,*S*-2,2′-isopropylidene-bis(4-phenyl-2-oxazoline) in acetonitrile. Focusing particularly on the homogeneous reaction, we show, by the use of an improved analytical procedure, that the

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true enantioselectivity of the reaction is much less than previously reported (35% ee). The discrepancy is attributable to the earlier use of chiral HPLC protocols that involved the injection of solutions of enantiomeric mixtures of aziridines in hexane, in which the racemates of the aziridine products are of low solubility. The phase behaviour of the ternary system hexane–*R*- and *S*-2-phenyl-*N*-(4-nitrobenzene-sulfonyl)aziridine has also been investigated in more detail.

Experimental

Catalyst preparation

Two catalysts were used in this study. Copper(II) triflate (Aldrich) was used as supplied. CuHY was prepared as follows: NH_4Y zeolite was calcined in air at 550 °C overnight to obtain HY zeolite. HY zeolite (4.0 g) was stirred in aqueous copper(II) sulfate (0.1 M, 100 mL) overnight at room temperature. The solution was then filtered and washed with distilled water. The catalyst was dried in an oven at 100 °C. The copper-zeolite was recalcined at 550 °C for 4 h prior to use. The Cu content was 1.7% by weight, which was determined by atomic absorption spectroscopy.

Prior to the catalytic reactions, CuHY (0.326 g, 1.7% weight Cu, 8.73×10^{-5} mol of Cu) and $Cu(OTf)_2$ (0.0316 g, 17.6% weight Cu, 8.73×10^{-5} mol) were stirred with the chiral modifier (*S*,*S*)-2,2′-isopropylidenebis(4-phenyl-2-oxazoline) (0.0584 g, 1.75×10^{-4} mol) in MeCN (5 mL) for 15 min at room temperature.

Synthesis of nitrene donors

Synthesis of (*N*-(*p*-tosylsulfonyl)imino)phenyliodinane (PhINTs). The synthesis was carried out following the method described by Yamada *et al*.[9] Potassium hydroxide (11.2 g, 0.2 mol) was mixed with *p*-toluenesulfonamide (13.68 g, 0.08 mmol) in a 500 mL round-bottomed flask containing HPLC grade methanol (320 mL), and the mixture stirred until complete dissolution had occurred. This solution was cooled to below 10 °C, iodobenzene diacetate (25.70 g, 0.08 mmol) added slowly and the mixture stirred over ice until a yellow solution was formed. The ice was removed and the mixture stirred at room temperature for a further 3 h. The mixture was then poured into distilled water (~800 mL), covered and refrigerated overnight. Over a period of 12 h, a yellow precipitate formed, and this was filtered, washed with distilled water and dried/stored in a desiccator in the dark until use. The ^{1}H NMR spectroscopic data were in agreement with the literature.

Synthesis of (*N*-(*p*-nosylsulfonyl)imino)phenyliodinane (PhINNs). Potassium hydroxide (11.2 g, 0.2 mmol) was mixed with 4-nitrobenzenesulfonamide (16.16 g, 0.08 mmol) in a 500 mL round-bottomed flask containing HPLC grade methanol (320 mL) and the mixture stirred until complete dissolution had occurred. This solution was cooled to below 10 °C and iodobenzene diacetate (25.70 g, 0.08 mmol) added slowly, keeping the temperature below 10 °C at all times. The mixture was stirred over ice until a cream precipitate was formed, at which point the ice was removed and the mixture stirred for a further 3 h at room temperature. The mixture was then poured into distilled water (~800 mL), covered and refrigerated overnight. The product was filtered, washed with distilled water and dried/stored in a desiccator in the dark until use. The ^{1}H NMR spectroscopic data agreed with literature values.[6]

Synthesis of (*S*)-(*N*-*p*-nosyl)-2-phenylaziridine. A method similar to that first described by Farrás *et al.*[10] was used. 4-Nitrobenzenesulfonyl chloride (13.3 g; 60 mmol) was added in one portion to a suspension of (*S*)-(+)-2-phenylglycinol in dry DCM–pyridine (2 : 1 v/v; 20 mL) at 0 °C, and the resulting mixture was stirred at room temperature for 4 h. It was then diluted with further DCM (300 mL) and washed with aqueous HCl (2 M; 3 × 100 mL); the aqueous washings were extracted with DCM (50 mL). The combined organic layers were carefully shaken with aqueous KOH (2 M; 6 × 200 mL), and the aqueous extracts subsequently extracted with DCM (150 mL). The organic portions were combined, washed with water (300 mL), dried (Na_2SO_4) and the solvent removed to yield (*S*)-(*N*-(*p*-nosylsulfonyl)imino)phenyliodinane, which was purified by flash chromatography twice using DCM. Recrystallisation was from DCM–hexane. NMR spectral data and $[\alpha]_D$ = +77.80 were in agreement with literature values.[10]

Catalytic reactions

Catalytic reactions were carried out using both homogeneous and heterogeneous catalysts.

Standard homogenous reaction. Copper triflate (0.0316 g, 8.73×10^{-5} mol) was stirred with the bis(oxazoline) chiral modifier (0.0584 g, 1.75×10^{-4} mol) in acetonitrile (5 mL) for 15 min. Styrene (100 μL, 8.73×10^{-4} mol) was added followed by the nitrene donor (PhINTs, 0.4886 g, or PhINNs, 0.5292 g; 1.31×10^{-3} mol) and the mixture stirred continuously until all the nitrene donor had been consumed. The product was isolated using flash column chromatography (1.5 × 20 cm silica, 10 : 1.5 petroleum ether 40–60 : ethyl acetate) and analysed by chiral HPLC. The aziridine was formed as a colourless crystalline solid. For the racemic reaction, the same procedure was followed, but without the addition of the chiral modifier. For *N*-(*p*-tosylsufonyl)-2-phenyl-aziridine: ^{1}H NMR ($CDCl_3$, 400 MHz) data agreed with the literature values.[4,5]

Standard heterogeneous reaction. CuHY (0.326 g, 1.7% weight Cu, 8.73×10^{-5} mol of Cu) was stirred with the bis(oxazoline) chiral modifier (0.0584 g, 1.75×10^{-4} mol) in acetonitrile (5 mL) for 15 min. Styrene (100 μL, 8.73×10^{-4} mol) was added followed by the nitrene donor (PhINTs, 0.4886 g, or PhINNs, 0.5292 g; 1.31×10^{-3} mol) and the mixture stirred continuously until the reaction had reached completion. The catalyst was removed by filtration and the product isolated using flash column chromatography (1.5 × 20 cm silica gel, 10 : 1.5 petroleum ether 40–60 : ethyl acetate) and analysed by chiral HPLC. Again, for the racemic reaction, the same procedure was followed but without the addition of the chiral modifier.

Analytical procedures

High pressure liquid chromatography analysis was performed using a Varian Pro-star HPLC system (PDA detector set to λ = 254 nm, a 230 Solvent delivery system and a 410 Autosampler). A Chiralcel OJ column of size 250 mm × 4.6 mm ID and a packing composition of cellulose tris(4-methylbenzoate) coated on 10 μm silica gel was first used to separate the chiral compounds. A solvent

Table 1 Crystal data and structure refinement

	1	2
Empirical formula	$C_{14}H_{12}N_2O_4S$	$C_{14}H_{12}N_2O_4S$
Formula weight	304.32	304.32
T/K	150(2)	100(2)
Crystal size/mm^3	$0.35 \times 0.30 \times 0.05$	$0.25 \times 0.05 \times 0.03$
Crystal system	Monoclinic	Monoclinic
Space group	$P2_1/a$	$P2_1$
a/Å	13.4830(5)	6.7710(3)
b/Å	7.5430(3)	26.8040(15)
c/Å	14.7650(5)	7.4480(3)
β (°)	114.997(2)	89.867(3)
Volume/Å^3	1360.98(9)	1351.73(11)
Z	4	4
ρ_{cal}/Mg m^{-3}	1.485	1.495
R_1 [$I > 2\sigma(I)$]	0.0450	0.0964
wR_2	0.0997	0.2224

mixture of hexane 70% : isopropanol 30% was used, pumped at a rate of 1 mL min^{-1}. The aziridines were prepared for chiral HPLC analysis by the addition of hexane.

A Chiralpak IA column of size 250 mm × 4.6 mm ID and a packing composition of amylose tris(3,5-dimethylphenylcarbamate) immobilized on 5 µm silica gel was used to replace the Chiralcel OJ column for separating the chiral compounds. A solvent mixture of hexane 85% : isopropanol 15% was used, pumped at a rate of 1 mL min^{-1}. The aziridines were prepared for chiral HPLC analysis by dissolving 5 mg in 1 mL THF and adding 4 mL hexane.

X-Ray crystallography

Data were recorded for crystalline racemic *N*-nosyl-2-phenylaziridine, **1**, and authentic *S*-enantiomer **2** on a Nonius Kappa CCD diffractometer equipped with an Oxford Cryosystem cryostat and a molybdenum source ($\lambda = 0.71073$ Å). The structures were solved by direct methods with additional light atoms found by Fourier methods using SHELX-97.[11] Hydrogen atoms were added at calculated positions and refined using a riding model. Anisotropic displacement parameters were used for all non-H atoms; H-atoms were given isotropic displacement parameters equal to 1.2 or 1.5 times the equivalent isotropic displacement parameter of the atom to which the H-atom is attached. The asymmetric unit of **2** consists of two independent molecules. The higher R indices for **2** are due to the weakness of the data resulting from the small size of the needles obtained. Crystal and refinement data are shown in Table 1.†

Results and discussion

Enantiomeric excess

The reactions of styrene with PhINNs catalysed by copper(II) triflate in homogeneous solution in acetonitrile and, heterogeneously, by CuHY in the same solvent in the presence of the chiral modifier *S*,*S*-2,2′-isopropylidene-bis(4-phenyl-2-oxazoline), were carried out as previously described, the mixtures of enantiomers isolated and the ee determined by HPLC. Comparison of the chromatographic behaviour of authentic *S*-2-phenyl-*N*-(4-nitrobenzenesulfonyl)aziridine ($[\alpha]_D = +77.80$), prepared from *S*-phenylglycinol and 4-nitrobenzenesulfonyl chloride, followed by cyclisation with alkali, with the product mixture from copper-catalysed aziridination showed that the *R*-(–)-aziridine was the enantiomer produced preferentially. This observation, in conjunction with the findings of Evans *et al.*[3] using PhINTs, shows that the sense of the stereochemical induction during aziridination is independent of the 4-substituent in the arenesulfonyl group. [Note: in some previous publications from this laboratory,[3] the absolute configuration of the aziridines produced from styrene using *S*,*S*- and *R*,*R*-bis(4-phenyloxazolines) was erroneously given as *S*- and *R*-*N*-arenesulfonyl-2-phenylaziridines, respectively].

In earlier work, the chiral column used for this analysis was a Chiralcel OJ column with a mixture of 2-propanol (IPA)/hexane as the mobile phase, analogous to that prescribed in the original papers of Evans and co-workers[2] for the analysis of *N*-tosylaziridines and also used by Sodergren *et al.* for aziridines with other substituents.[5] This column is packed with cellulose tris(4-methylbenzoate) coated on 10 µm silica gel. Only alkane and alcohol solvents can be used with this type of column; other solvents commonly used in HPLC eluents such as tetrahydrofuran (THF) and dichloromethane (DCM) can damage the chiral stationary phase if they are present, even in residual quantities. Injection of the mixture of enantiomeric aziridines for analysis was therefore done in a hexane solution, but we noted that the analyte was often quite difficult to dissolve. Analysis of the mixture of enantiomeric *N*-nosyl-2-phenyl-aziridines using this procedure, with a mobile phase consisting of hexane (70%) and 2-propanol (IPA, 30%), indicated the reproducibly of an enantiomeric excess of 90% of the *R*-enantiomer. In the present investigation, enantiomeric analyses were conducted using a more robust Chiralpak IA column. This column has a packing composition of amylose tris(3,5-dimethylphenylcarbamate) immobilized on 5 µm silica gel, which allowed the free choice of any miscible solvent for the injection and to make up the mobile phase. Using a modified procedure, in which the analyte was first dissolved in THF and the solution diluted with four times its volume of hexane prior to injection, and with hexane (85%) and IPA (15%) as the mobile phase, the ee was observed to be only 35% *R*. Polarimetric measurement of the enantiometric composition gave $[\alpha]_D = -22.4°$, corresponding to an ee of 29%, supporting the correctness of the more accurate HPLC analysis. The ee value can be compared with the 66% reported by Sodergren *et al.*[4,5] using an analytical procedure similar to our use of the Chiralcel OJ column, which, as indicated above, we have now demonstrated over-reports the ee. Other studies have been published[12,13] in which nosyl-2-phenylaziridines have been made and their ee values determined using similar, suspect procedures. In all three instances, the reliability of the ee values cannot be assessed without knowledge of the composition of the solvent used for injection onto the chiral HPLC column.

The results of experiments, in which the injection solvent and mobile phase were varied, are shown in Table 2. It is evident that the origin of the discrepancy in the observed ee lies in the use of hexane as the solvent for the injection of the mixture of enantiomers. We reasoned that, although the enantiomeric *N*-nosylaziridines appeared soluble in hexane, a true racemate might be less soluble so that the solution actually injected onto the chiral HPLC column could contain largely the enantiomer in excess.

Table 2 HPLC analysis of enantiomeric 2-phenyl-*N*-(4-nitrobenzenesulfonyl)aziridines[a]

Column	Mobile phase	Sample injection solvent	Enantiomeric excess (%)
Chiralcel OJ	70% hexane : 30% IPA	100% hexane	90 *R*
Chiralpak IA	85% hexane : 15% IPA	100% hexane	90 *R*
Chiralpak IA	85% hexane : 15% IPA	20% THF : 80% hexane	35 *R*
Chiralpak IA	20% THF : 80% hexane	20% THF : 80% hexane	36 *R*

[a] Reaction conditions used to make the nosyl aziridine: air, RT, 12 h reaction time, MeCN (5 mL), $Cu(OTf)_2$ (4.15×10^{-5} mol of Cu), bis(oxazoline) (1.17×10^{-4} mol), PhINNs (1.46×10^{-3} mol), styrene (9.69×10^{-4} mol).

Table 3 Enantiomeric excesses for the solution phase and solid phase in ternary mixtures hexane–*R*- and *S*-*N*-arenesulfonyl-2-phenylaziridines

ee of aziridine mixture	Aziridine/hexane/ mg_{Az} $mL_{C_6H_{12}}^{-1}$	ee of hexane solution (%)	ee of solid (%)
***N*-Nosylaziridine**			
28	0.29	81 (*R*)	10.5 (*R*)
35	0.25	73 (*R*)	19 (*R*)
26	0.20	72 (*R*)	3 (*R*)
***N*-Tosylaziridine**			
28	27	70 (*R*)	—
28	3.6	41 (*R*)	—
28	2.0	32 (*R*)	—
28	1.0	28 (*R*)	—

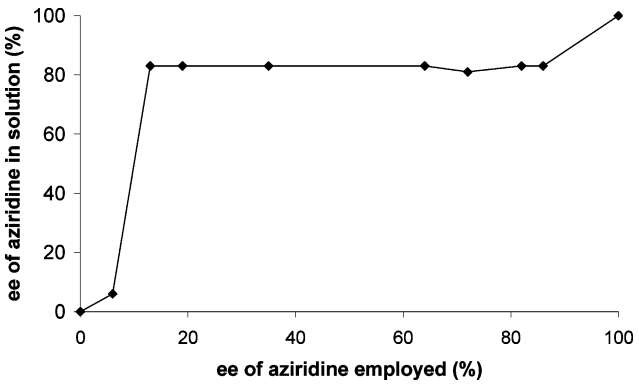

Fig. 1 Observed ee of the hexane solution phase in mixtures of enantiomeric *N*-nosyl-2-phenylaziridines.

The ternary system: hexane–*R*- and *S*-2-phenyl-*N*-(4-nitrobenzenesulfonyl)aziridine

In order to understand the role of the injection solvent on the enantiomer analysis, we undertook solubility tests in hexane on *N*-nosyl- and *N*-tosyl-2-phenylaziridines, examining the ee for the aziridines in hexane solution and that for the residual insoluble aziridine using a Chiralpak IA HPLC column and THF dissolution of the analyte; the results are shown in Table 3. It is evident that for *N*-tosylaziridine, a concentration as high as 1 mg mL^{-1} of hexane correctly produced the true ee of the original enantiomeric mixture. At much higher ratios of enantiomeric aziridines to hexane, which far exceeded the solubility, the observed ee of the solution phase did increase but we consider that the published ee values for *N*-tosylaziridines are correct. For the much less soluble *N*-nosyl-2-phenylaziridines, solid material was always present in the mixtures in Table 3, and this solid showed a much lower ee than both the solution phase and the original mixture of enantiomers. Clearly, the racemate remains largely in the solid phase, indicating that it is less soluble than either of the enantiomers separately; the enantiomer in excess is concentrated in the solution phase. The situation is akin to that described by Blackmond and co-workers[14] in the case of *R*- and *S*-prolines in dimethyl sulfoxide.

Two other sets of experiments were carried out. In the first, enantiomeric mixtures of *N*-nosyl-2-phenylaziridines were prepared with ee values ranging from 5 to 100% by mixing the pure *S*-enantiomer with the racemic material. The solids (1 mg) were then equilibrated with hexane (1 mL) and the liquid phase analysed using a Chiralpak IA HPLC column; the results are shown Fig. 1 and show that HPLC analysis of the hexane solution produced from enantiomeric mixtures in the range from 10 to 90% ee always indicate an ee of 82%. This then is the solution composition at the eutectic point when the saturated solution in hexane is in equilibrium with the solid racemate and the pure solid enantiomer in excess. For solid material of less than 10% ee or greater than 90% ee at a ratio of 1 mg mL^{-1} hexane, the HPLC analysis of the solution corresponds to the input composition, because there is insufficient excess enantiomer or racemate for both solid phases to be present.

The other set of experiments was concerned with examining the abilities of different solvents to produce solutions of high ee from mixtures of enantiomers. Samples (1 mg) of *N*-nosyl-2-phenylaziridine of 33% ee were added to a range of solvents and the resulting liquid phase was analysed by HPLC. The aziridine was fully soluble in DCM, THF and CH_3CN, and the observed ee of the solution was 33%. The aziridine was less soluble in ethanol, but the solution still showed a 33% ee, whereas with IPA the ee was 48%. Aziridine solubility in hydrocarbon solvents is very

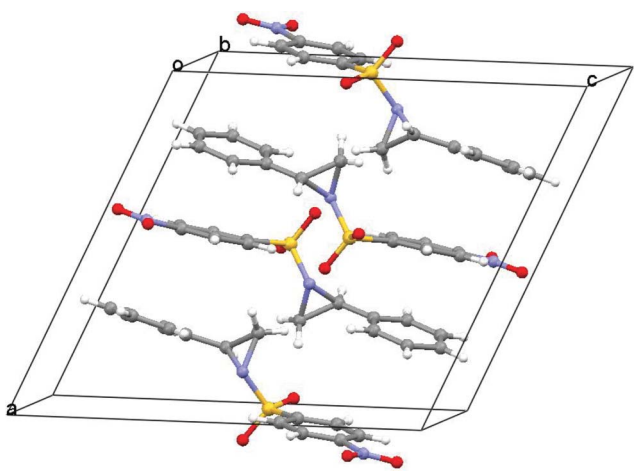

Fig. 2 A unit cell of the racemate of *N*-nosyl-2-phenylaziridine (**1**).

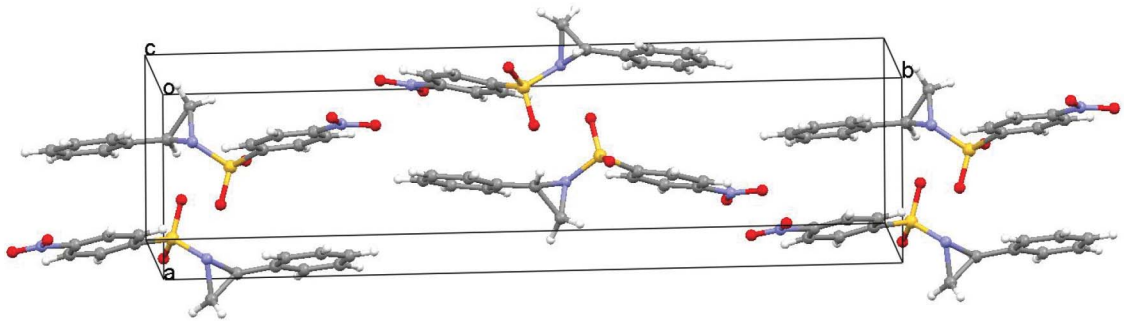

Fig. 3 A segment of the structure of (*S*)-*N*-nosyl-2-phenylaziridine (**2**) showing the unit cell.

much lower, and the following ee values were observed: hexane, 82%; cyclohexane, 84%; heptane, 91%; pentane, 94%.

X-Ray crystallography

Support for the correctness of our interpretation of the pattern of behaviour described above comes from X-ray crystallographic studies. Treatment of an enantiomeric mixture of *N*-nosyl-2-phenylaziridines with hexane, followed by separation of the insoluble solid, afforded a material that on recrystallisation from dichloromethane gave crystals of racemate, **1**; the crystallographic details are in Table 1. The crystal structure of **1** shows a racemic assembly of *R*- and *S*-enantiomeric molecules of *N*-nosyl-2-phenylaziridine, as dictated by the crystallographic symmetry. The unit cell contains two pairs of enantiomeric molecules, as shown in Fig. 2.

The corresponding crystallographic results for the pure *S*-enantiomer, **2**, synthesised from *S*-phenylglycinol, are shown in Table 1. The crystal structure of **2** is chiral and a segment of the structure is shown in Fig. 3. The two independent molecules in the asymmetric unit assume identical conformations but are distinguishable by the variable geometry of their intermolecular contacts. A different crystal structure has also been reported previously[15] for (*S*)-*N*-nosyl-2-phenylaziridine, and therefore structure **2** represents a second polymorphic form.

Enantioselectivity in the aziridination of substituted styrenes

We take this opportunity of correcting the enantiomeric excesses of aziridines formed by the reaction of PhINNs with ring-substituted styrenes catalysed by copper(II) triflate and by CuHY.[16] Reactions were conducted in an identical manner to those described by Ryan *et al.*,[16] but enantiomeric analyses were carried out using a Chiralpak IA HPLC column with injection of the aziridines in THF diluted with hexane; the results are shown in Table 4, which also gives the incorrect ee values reported earlier and the ee of the saturated solution in hexane produced when the enantiomeric product mixture (1 mg) was treated with hexane (1 mL) alone. The corrected ee for each of the substituents is much less than previously reported, being about 30%. The high ee values for the hexane-soluble fractions confirm the pattern of behaviour established for *N*-nosyl-2-phenylaziridines, namely that these compounds form a solid racemate that is less soluble in hexane than the pure enantiomers. Clearly, pure enantiomers can be readily separated from enantiomeric mixtures of low ee, particularly by the use of hydrocarbon solvents.

Table 4 Enantiomeric excesses for *N*-nosylaziridines from styrene derivatives

	Reported % ee of aziridine[10]			
Styrene substituent	CuHY	$Cu(OTf)_2$	Corrected % ee of aziridine	% ee of aziridine dissolved in hexane[a]
3-F	(*S*) 58	(*S*) 83	(*R*) 25	(*R*) 94
4-CH_3	(*S*) 67	(*S*) 66	(*S*) 25	(*S*) 89
3-Cl	(*S*) 95	(*S*) 72	(*R*) 30	(*R*) 87

[a] 1 mg azirdine : 1 mL hexane.

Conclusions

By synthesising (*S*)-*N*-nosyl-2-phenylaziridine from (*S*)-(+)-phenylglycinol, it has been shown that the aziridination of styrene and substituted styrenes by PhINNs in the presence of the chiral modifier *S*,*S*-2,2′-isopropylidene-bis(4-phenyl-2-oxazoline), catalysed either by copper(II) triflate in homogeneous solution in CH_3CN or heterogeneously by CuHY, again in the presence of the same solvent, yields predominantly the *R*-enantiomer. Using an improved analytical procedure, it is shown that previous reports of high enantioselectivity in such reactions are erroneous. It has been demonstrated that the treatment of enantiomeric mixtures of *N*-nosyl-2-phenylaziridine with hexane-rich solvents leads to the separation of a solid phase that consists largely of the solid racemic compound and a solution phase that contains mostly the enantiomer originally present in excess. The previously reported ee values for *N*-tosyl-2-phenyl aziridines are considered to be correct. However, it is apparent that the relative solubilities of the racemate and the pure enantiomers in hexane can be used to obtain the enantiomer in high ee.

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