Experimental Section[10]

Reagents. Trimethylchlorosilane (3) was purified by distillation from 5 wt % sucrose and tri-*n*-butylamine to remove polychlorosilane derivatives.[11] The alkyl sulfonamides were prepared from the corresponding sulfonyl chlorides using a benzene solution of anhydrous ammonia.[12] Commercially available *p*-toluenesulfonyl isocyanate was used without further purification for preparative procedures. Since this material is contaminated with *p*-toluenesulfonyl chloride, which is difficult to remove, pure *p*-toluenesulfonyl isocyanate, bp 100° (0.5 mm), was prepared *via* the silylated carbamate procedure to use for infrared kinetic studies. *O*-Ethyl-*N*-alkylsulfonyl carbamates were prepared according to the general procedure of Cassady, *et al.*;[7] yields and melting points are reported in Table II. *O*-Alkyl-*p*-toluenesulfonyl carbamates were obtained by addition of the appropriate alcohol to a solution of *p*-toluenesulfonyl isocyanate in ether.

Silylation of *O*-Neopentyl-*N*-*p*-toluenesulfonyl Carbamate (4). The following general procedure was used to prepare the silylated sulfonyl carbamates. A solution of 3.84 g (13.46 mmol) of 4 in a mixture of 5 ml of acetonitrile and 30 ml of benzene was mixed with 5.85 g (54 mmol) of 3 and cooled in an ice bath. After slowly adding a solution of 1.37 g (13.5 mmol) of triethylamine in 10 ml of benzene, the reaction mixture was stirred at 20° for 1.5 hr. The excess trimethylchlorosilane was evaporated *in vacuo*, 25 ml of cyclohexane was added, and the triethylammonium salt was removed by filtration. The filtrate was concentrated *in vacuo* to yield 4.84 g of a mixture of 5 and 6: nmr (benzene-d_6) δ 7.88 (d, 2 H), 6.87 (d, 2 H), 3.70 (s, 2 H), 2.09 (s, 3 H), 0.81 (s, 9 H), 0.23 (s, 6.8 H), 0.18 (s, 1.2 H). Although the absorptions below δ 0.5 were slightly broader than expected, it was not possible to resolve these signals and confirm the presence of an isomer mixture. The spectrum is consistent with a 90% yield of an 85:15 mixture of 5 and 6, based upon the relative intensities of the silylmethyl proton absorption.

Silylation of *O*-ethyl-*N*-methylsulfonyl carbamate was conducted exactly as described above using 3.35 g (20 mmol) of **4a**, 8.7 g (80 mmol) of $(CH_3)_3SiCl$, and 2.02 g (20 mmol) of trimethylamine. Evaporation of the solvent mixture yielded 4.63 g of viscous oil, nmr (benzene-d_6) δ 3.99 (q, 2 H), 2.95 (s, 3 H), 1.09 (t, 3 H), 0.37 (s, 2.1 H), 0.28 (s, 4.9 H).

***O*-Ethyl-*N*-ethylsulfonyl carbamate (4b)** was silylated using 3.63 g (20 mmol) of **4b**, 8.7 g (80 mmol) of $(CH_3)_3SiCl$, and 2.02 g (20 mmol) of triethylamine; 4.71 g of oil remained, nmr (benzene-d_6) δ 3.98 (a, 2 H), 3.05 (m, 2.8 H) 1.17 (d of t, 7.7 H) 0.41, (s, 2.1 H), 0.28 (s, 4.4 H). The residual oil appears to be a mixture of **5b** and **6b**; ir (neat) 2250 (NCO), 1740 (C=O), and 1085 cm^{-1} (SiO) confirms this analysis.

Butanesulfonyl isocyanate (14) was prepared directly from *O*-ethyl-*N*-butanesulfonyl carbamate (**16**) without isolating the silylated intermediate. Addition of triethylamine (21.2 g, 0.209 mol) to a cooled solution of 43.7 g (0.209 mol) of **16** and 68.5 g (0.63 mol) of **3** in 140 ml of benzene effected the silylation. After the reaction mixture was stirred for 2 hr, the excess trimethylchlorosilane and ~25 ml of solvent were evaporated under reduced pressure. The residue was filtered under nitrogen and then the remaining solvent was evaporated. The residual oil was redissolved in 70 ml of acetonitrile and refluxed for 2 hr. Evaporation of the acetonitrile followed by vacuum distillation of the residue yielded 24.5 g (72%) of **14**: bp 78° (3 mm); ir (neat) 2240, 1350, 1150 cm^{-1}; nmr (CD_3CN) δ 3.2 (t, 2 H), 1.76–0.86 (m, 4 H), 0.67 (t, 3 H).

A similar procedure was utilized to prepare each of the sulfonyl isocyanates cited in Table II.

(−)-2-Octyloxytrimethylsilane (11). Method A. A solution of 5.38 g (0.041 mol) of **9**, $[\alpha]^{25}D$ (cyclohexane) −8.57°, in 50 ml of benzene was treated with 13.3 g (0.122 mol) of **3** and cooled to 5°. Following injection of 4.12 g (0.041 mol) of triethylamine, the mixture was allowed to warm to 37° and stirred for 3 hr. The excess trimethylchlorosilane was evaporated under reduced pressure, the triethylammonium chloride was removed by filtration under nitrogen, and the filtrate was treated with 2.0 g of *p*-toluenesulfonyl isocyanate to remove unreacted alcohol. Fractional distillation of the filtrate yielded 6.12 g (74%) of **11**, bp 70° (10 mm), $[\alpha]^{25}D$ (cyclohexane) −13.58°.

Method B. A solution of 9.70 g (0.049 mol) of *p*-toluenesulfonyl isocyanate in 40 ml of ether was mixed with an ethereal solution of **9** (6.40 g in 10 ml). After 1 hr the ether was evaporated and the residual oil **10**) was used without further purification. The silylation of **10**, 14.9 g (0.045 mol), with 14.7 g (0.135 mol) of **3** was catalyzed by addition of 4.6 g of triethylamine to a benzene solution of the reagents. The silylated sulfonyl carbamate was isolated and thermolyzed in acetonitrile in the usual manner. Fractional distillation of the product mixture yielded 8.12 g (74.5%) of **11**, bp 63° (6 mm), $[\alpha]^{25}D$ (cyclohexane) −14.68°.

Anal. Calcd for $C_{11}H_{25}OSi$: C, 65.62; H, 12.41; Si, 13.92. Found: C, 65.32; H, 12.38; Si, 13.67.

Reaction of *n*-Butylsulfonyl Isocyanate with Cellulose. A stirred, nitrogen-flushed mixture of 1.00 g (0.006 molar equiv) of wood cellulose in 50 ml of anhydrous pyridine was treated with 4.00 g (0.027 mol) of *n*-butylsulfonyl isocyanate at 85° for 6 hr. A clear solution was obtained within 30 min. The product was precipitated by pouring the reaction mixture into 500 ml of cold 50% ethanol–water which had been acidified with 50 ml of concentrated HCl. The polymer was dissolved in acetone, reprecipitated with acidified ice water, washed free of excess acid, and dried *in vacuo* at 60° for 12 hr; 3.63 g (D.S. = 2.6) of white powder was obtained. The butylsulfonyl carbamylated cellulose was soluble in acetone, DMF, and 2% NaOH, and swollen by ethanol.

Registry No.—**3**, 75-77-4; **4**, 32363-28-3; **5**, 51003-72-6; **5b**, 51003-73-7; **6**, 51003-74-8; **6a**, 51003-75-9; **6b**, 51003-76-0; **9**, 51003-19-1; **11**, 51003-20-4; *p*-toluenesulfonyl isocyanate, 4083-64-1; $CH_3CH_2O_2CCl$, 541-41-3.

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Lewis Acid Catalyzed Addition of Isocyanates to Sulfonamides

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The potential chemotherapeutic value of arylsulfonylureas as oral hypoglycemic agents has promoted intensive interest in their synthesis and chemical properties. Most of the preparative procedures described in the literature utilize arylsulfonamide salts, generated by inorganic bases or tertiary amines, as nucleophiles to add to isocyanates and related derivatives,[1] or to *sym*-1,3-dialkylureas.[2] Recently, an improved method for the preparation of arylsulfonyl isocyanates has increased the applicability of these highly reactive intermediates in arylsulfonylurea preparations.[3] We wish to describe a new approach to arylsulfonylurea synthesis which involves the direct condensation of arylsulfonamides with alkyl or aryl isocyanates in the presence of Lewis acid catalysts.

The Friedel–Crafts condensation of isocyanates with aromatic compounds in the presence of aluminum chloride was first reported by Leuckart in 1885.[4] This reaction has been evaluated more recently by Effenberger and Gleiter and the electrophilic character of the condensation was established.[5] The Friedel–Crafts reactivity of an isocyanate–Lewis acid complex toward the aromatic nucleus is

Table I
Electrophilic Condensation of *n*-Butyl Isocyanate with Sulfonamides,[a] RSO_2NH_2

Expt	Registry no.	R	Yield, %[b]	Mp, °C[c]
1	1129-26-6	CH_3O–	80	128 (lit.[e] 128–129)
2	70-55-3	CH_3–	76[j]	129 (lit.[d] 127–128)
3	98-64-6	Cl–	64	119–120 (lit.[d] 118.5–120)
4	3119-02-6	N≡C–	78	185 (lit.[f] 181)
5	6325-93-5	O_2N–	84	165–166 (lit.[e] 165–168)
6	13852-81-8	Cl–, NO_2	85	169.5[g]
7	16993-45-6		91	220–222 dec (lit.[i] 218–220 dec)
8	46249-41-6	$ClSO_2$–	80.5	143–144[g]
9	640-61-9	CH_3–, SO_2NHCH_3	100	46[g]
10	3144-09-0	CH_3	100	172–174 (lit.[h] 168)

[a] Prepared in nitrobenzene using $AlCl_3$ as the catalyst. [b] Yield of recrystallized product. [c] Measured with a Du Pont 900 Differential Thermal Analyzer. [d] F. J. Marshall and M. V. Segal, *J. Org. Chem.*, **23**, 927 (1958). [e] R. Tull, *et al.*, *J. Chem. Soc. C*, 701 (1967). [f] J. Lederer, *J. Med. Chem.*, **7**, 370 (1964). [g] Satisfactory elemental and spectral analyses were obtained for all new compounds. [h] O. Bayer and E. Cauer, French Patent 993,465 (Oct 31, 1961); *Chem. Abstr.*, **51**, 11380*f* (1961). [i] D. F. Hayman, *et al.*, *J. Pharm. Pharmacol.*, **14**, 451 (1962). [j] *n*-Propyl isocyanate was used in place of *n*-butyl isocyanate.

similar to that of acyl halide–aluminum chloride complexes, *i.e.*, anisole ~ mesitylene > toluene > benzene > chlorobenzene. Aromatic rings deactivated by nitro or sulfonyl substituents do not react with these complexes.

Discussion

Our survey of the literature did not reveal any evaluation of the reactivity of sulfonamides with electrophilic reagents. However, the unpaired electrons on the sulfonamide linkage can attack an electrophile as illustrated in eq 1. We have observed that addition of an isocyanate–Lewis acid complex, such as **1**, to a sulfonamide produces an arylsulfonylurea–aluminum chloride complex (**2**), which can be hydrolyzed with dilute hydrochloric acid to liberate the desired product.

$$ArSO_2NH_2 + RN{=}\overset{+}{C}{-}\underline{\bar{O}}{-}\bar{A}lCl_3 \longrightarrow$$

1

$$\left[\begin{array}{l} ArSO_2\overset{+}{N}H_2 \\ | \\ Cl_3\underline{\bar{A}l}{-}\underline{\bar{O}}{-}C{=}NR \end{array}\right] \longrightarrow \begin{array}{l} ArSO_2NH \\ | \\ Cl_3\underline{\bar{A}l}{-}\underline{\bar{O}}{-}\overset{+}{C}{-}NHR \end{array} \xrightarrow[HCl]{H_2O}$$

2

$$ArSO_2NHCNHR + Al(OH)_3 \quad (1)$$
$$\|$$
$$O$$

The scope of the reaction is illustrated in Table I. Note that two of the common hypoglycemic agents, tolbutamide (expt 2) and chlorpropamide (expt 3), can be prepared in 80 and 76% yield, respectively. The sulfonyl group effectively deactivates the aromatic nucleus; no evidence for arylcarboxamide derivatives was observed even in the presence of a strong electron-donating substituent (expt 1). Aromatic functional groups with high π-electron densities such as cyano or nitro moieties do not interfere with the condensation (expt 5–7). The procedure is ideal for preparing bis(*N'*-alkyl-*N*-aryl)sulfonyl ureas. We are able to prepare polyfunctional arylsulfonylureas with base-sensitive substituents (expt 8). This is a unique feature of our procedure and arylsulfonylureas with sulfonyl chloride substituents provide further possibilities for elaboration of sulfa drugs. N-Alkylated sulfonamides, which do not react with isocyanates under basic conditions,[6] can be converted to the corresponding sulfonylureas by our method. Alkylsulfonamides can also be utilized as substrates (expt 10).

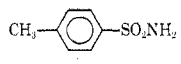
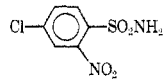
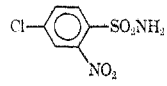
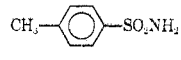
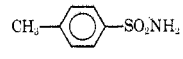
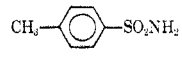
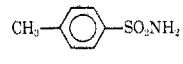
The yields cited in Table I refer to pure recrystallized product; the raw yield is essentially quantitative in most cases. The reaction can be employed to prepare poly(arylsulfonylureas) by the adding of diisocyanates to disulfonamides. For example, treatment of benzene-1,4-disulfonamide with hexamethylene diisocyanate yields a polymer of the following structure.

$$-\!\left[NHSO_2-C_6H_4-SO_2NHCNH(CH_2)_6NHC\right]_x\!-$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\quad O \qquad\qquad O$$

Polymers of this type are potentially useful as ion-exchange resins because the arylsulfonylurea linkage is a relatively strong acid.

The nature of the reagents which add electrophilically to arylsulfonamides was evaluated and the results are summarized in Table II. Aryl and alkyl isocyanates react equally well. The more sterically hindered cyclohexyl isocyanates condensed easily with ortho-substituted arylsulfonamides. Although aryl isocyanates are known to dimer-

Table II
Electrophilic Addends to Arylsulfonamides[a]

Arylsulfonamide	Addend	Registry no.	Yield,[b] %	Mp, °C[c]
	Cyclohexyl isocyanate	3173-53-3	95	178 (lit. 171–173)[d]
	Cyclohexyl isocyanate		70	210 dec[e]
	Phenyl isocyanate	103-71-9	75	163 dec[e]
	PhCCl ‖ O	98-88-4	89	148 (lit. 145–148)[f]
	CH_3CCl ‖ O	75-36-5	88	138 (lit. 136–138)[g]
	$(CH_3)_2NCCl$ ‖ X; X = O, S		No reaction	
	ROCCl ‖ O; R = Ph, Et		No reaction	

[a] Reaction conditions: arylsulfonamide:addend:$AlCl_3$, 0.01:0.01:0.012 *M* in 50 ml of nitrobenzene at 80° for 4 hr. [b] Yield of recrystallized product. [c] Determined by DTA. [d] G. Brzozowaki and R. Zdzislaw, *Rocz. Chem.*, **43,** 1761 (1969). [e] Satisfactory elemental and spectral analyses were obtained for all new compounds. [f] H. Bock, E. Baltin, and J. Kroner, *Chem. Ber.*, **99,** 3337 (1966). [g] A. Novacek, *Collect. Czech. Chem. Commun.*, **32,** 1712 (1967).

ize and trimerize in the presence of Lewis acid catalysts,[7] no evidence for side reactions of this type was observed. Phenyl isothiocyanate and *p*-toluenesulfonyl isocyanate failed to react with *p*-toluenesulfonamide in nitrobenzene at 80°. A potential intermediate in the condensation of isocyanates in the presence of aluminum chloride is the corresponding carbamoyl chloride. Although this possibility is unlikely because the condensation is conducted at temperatures at which carbamoyl chlorides dissociate to isocyanates and HCl,[8] a carbamoyl intermediate can be eliminated since dimethyl carbamoyl chloride failed to react with *p*-toluenesulfonamide. Benzyl chloride, phenyl chloroformate, and ethyl chloroformate failed to react with sulfonamides in the presence of aluminum chloride. On the other hand, benzoyl chloride and acetyl chloride react readily under these reaction conditions to yield *N*-(*p*-toluenesulfonyl)benzamide and *N*-(*p*-toluenesulfonyl)acetamide, respectively. These reactions demonstrate the acylation potential of aryl sulfonamides with acid chlorides.

We have attempted to elucidate the structure of the isocyanate–aluminum chloride complex by infrared analysis of nitrobenzene solutions with different aluminum chloride:butyl isocyanate ratios. The free isocyanate band at 2280 cm^{-1} is reduced to a constant minimum value when the $AlCl_3$:BuNCO ratio is 0.8:1. This disappearance is accompanied by the formation of four new bands in the spectra at 3385, 2340, 1770, and 1670 cm^{-1}. Since each of the bands develops at a different rate, it is likely that four different complexes are involved. Apparently, the aluminum chloride–isocyanate system ranges from a complex of two isocyanate moieties per $AlCl_3$ molecule to a polymeric complex capable of accepting up to 10 mol of $AlCl_3$/mol of isocyanate and elucidation of the structure of the active complex will require further experiments.

Variation of the reaction conditions also revealed some interesting phenomena. No reaction occurred in dioxane, acetonitrile, or nitromethane, but the addition proceeded normally in chloroform and carbon disulfide–benzene mixtures. The latter solvent system was less satisfactory than nitrobenzene because the isocyanate complex reacted with the benzene to produce by-products. The best procedure for synthesis of the arylsulfonylureas is to heat a slurry of the arylsulfonamide, isocyanate, and Lewis acid to 80° for 2 hr. Subsequent treatment of the solid sulfonylurea complex with cold dilute hydrochloric acid liberates pure arylsulfonylurea. Although aluminum chloride was used as a catalyst for most of this work, less reactive Lewis acids such as anhydrous ferric chloride and stannic chloride were equally effective.

Experimental Section

Reagents. Commercially available arylsulfonamides and isocyanates were used without further purification.

***N*-Arylsulfonyl-*N'*-butylureas. A. Solution Method.** A solution of *n*-butyl isocyanate (1.0 g, 0.01 mol) in 50 ml of nitrobenzene was added to 1.5 g (0.0113 mol) of anhydrous aluminum chloride, stirring was initiated, and, when a clear solution of the isocyanate–$AlCl_3$ complex formed, the arylsulfonamide (0.01 mol) was added. The solution was heated to 80° for 4 hr, and then 15–20 ml of nitrobenzene was distilled from the reaction mixture under reduced pressure. The residue was poured into 300 ml of ice water containing 10 ml of hydrochloric acid. The product was precipitated from the nitrobenzene phase by addition of petroleum ether.

B. Slurry Method. A mixture of 1.5 g (0.0113 mol) of anhydrous aluminum chloride, 0.01 mol of arylsulfonamide, and 0.01 mol of isocyanate was heated at 80° for 0.5 hr. The reaction mixture was cooled and triturated with 30 ml of cold, 10% HCl to break up the product complex, and the arylsulfonylurea was isolated by extracting the aqueous slurry with two 30-ml aliquots of ether. The ether solution was dried over anhydrous sodium sulfate and evaporated to yield the desired product.

Poly(benzene-1,4-disulfonylhexamethyleneurea). A solution of 2.577 g (0.01 mol) of benzene-1,4-disulfonamide in 50 ml of nitrobenzene was allowed to react with 1.682 g (0.01 mol) of hexamethylene diisocyanate in the presence of 2.7 g (0.02 mol) of aluminum chloride at 80° for 15 hr. The homogeneous reaction mixture was cooled to 25° and poured into 100 ml of 5% HCl to precipitate the polyurea. The polymer was soluble in DMF, DMSO,

and 5% KOH, and could be purified by reprecipitating from a DMF solution into acetone followed by a second reprecipitation from DMF into water. The purified polymer exhibited η_{inh} = 0.132 in DMF and decomposed upon heating to 220°. *Anal.* Calcd for $C_{14}H_{20}N_4O_6S$: C, 39.5; H, 4.70; N, 13.14. Found: C, 40.63; H, 5.01; N, 13.58.

Investigation of the $AlCl_3$–*n*-Butyl Isocyanate Complex. A 0.1 *M* stock solution of *n*-butyl isocyanate in nitrobenzene was used for all of the measurements. A 1.0 *M* solution of $AlCl_3$ in nitrobenzene was used to prepare a second 0.1 *M* stock solution and these two solutions were used to prepare complex solutions where the concentration of $AlCl_3$ ranged from 0.005 to 0.5 *M* and the concentration of *n*-butyl isocyanate was held constant at 0.05 *M*. The complex solutions were allowed to stand at 25° for at least 30 min before the infrared spectra were recorded with a Perkin-Elmer Model 621 spectrometer. The spectra of the solutions were measured at ambient temperature in matched 0.4-mm sodium chloride cells using nitrobenzene as a reference.

Registry No.—*n*-Butyl isocyanate, 111-36-4; hexamethylene diisocyanate, 822-06-0; poly(benzene-1,4-disulfonylhexamethyleneurea), 51002-85-8; benzene-1,4-disulfonamide polymer with hexamethylene diisocyanate, 51002-86-9.

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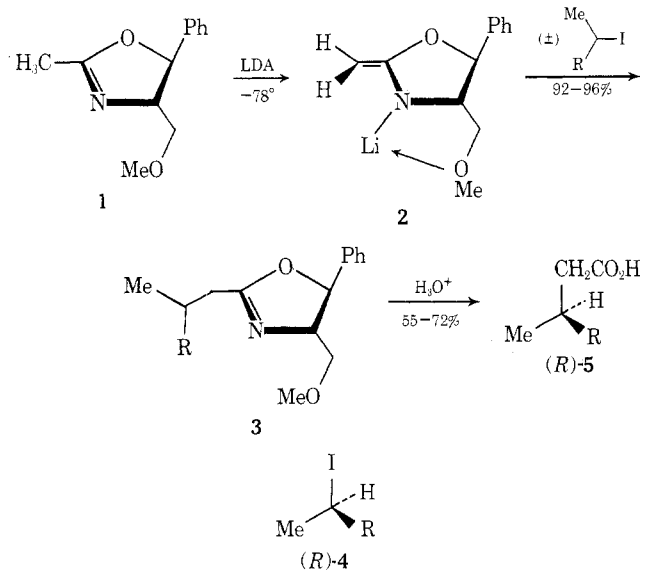
Communications

Synthesis *via* Oxazolines. V. A Simultaneous Kinetic Resolution of *sec*-Alkyl Iodides and Synthesis of Optically Active 3-Alkylalkanoic Acids. A Method for Determination of Absolute Configuration and Maximum Optical Rotations

Summary: Reaction of racemic *sec*-alkyl iodides with a chiral oxazoline carbanion results in 30–40% stereoselective alkylation of the S enantiomer of the halide and allows recovery of *R*-enriched halide.

Sir: We recently reported the use of chiral nonracemic oxazolines in the asymmetric synthesis of α-methylalkanoic acids.[1] Further studies on the 2-methyl derivative **1** of this heterocyclic system have now revealed that it is capable of chiral recognition in nucleophilic substitution of *sec*-alkyl halides resulting in simultaneous formation of optically active halides and 3-methylalkanoic acids *via* kinetic resolutions.[2]

Treatment of **1**[3] with 1.0 equiv of lithium diisopropylamide (LDA) gave the lithio salt **2** (THF, −78°). Addition of 2.0 equiv of racemic 2-iodoalkanes (−40 to −60°, 6–8 hr) produced, after quenching, the alkylated oxazoline **3** in 92–96% yield along with recovered iodoalkane **4** which



was 25–30% optically pure and possessed the *R* configuration (Table I). Hydrolysis (3 *N* HCl, 2 hr) of the alkylated oxazoline **3** afforded the 3-methylalkanoic acids **5** in comparable (±3%) optical purity and also possessing the *R* configuration (Table I). Aside from the asymmetric synthesis of the carboxylic acids and the kinetic resolution of the halides in moderate optical yields, this technique offers a rather significant dividend. *It should be feasible to predict, within a few per cent, the maximum rotation of one of the reaction products (halide or acid) provided that the other is known.* This prediction is substantiated by the following events. Reaction of **1** with 2.0 equiv of racemic 2-iodooctane gave recovered halide (*R*)-**4** (R = hexyl) in 85% yield with an optical purity of 24–30% (Table I). However, the carboxylic acid (*R*)-**5** was formed in 53% optical purity based upon a reported value of −4.7°

Table I
Optically Active *sec*-Alkyl Iodides, (*R*)-4, and 3-Methylalkanoic Acids, (*R*)-5

Iodide 4,[a,b] R	$[\alpha]_D^{25}$ (neat), degree	Optical purity,[c] %	Acid 5,[a] R	$[\alpha]_D^{25}$ (neat), degree	Optical purity, %
Et	−9.4	27–29[d]	Et	−2.6	31[e]
n-Propyl	−10.6	24–29	*n*-Propyl	+0.7	26–28[e]
n-Hexyl	−15.0	25–30[f]	*n*-Hexyl	+2.4	34[g]

[a] Recovered in 81–96% yield. [b] To avoid enrichment by fractionating, all materials were distilled to <10% of residue. [c] Based upon highest values reported: **2-iodobutane,** $[\alpha]_D$ −31.98° (neat), and **2-iodopentane** $[\alpha]_D$ −37.15° (neat), R. H. Pickard and J. Kenyon, *J. Chem. Soc.*, **99,** 45 (1911); $[\alpha]_D$ 46.7° (neat), D. H. Brauns, *Recl. Trav. Chim. Pays-Bas,* **65,** 799 (1946); **2-iodooctane,** $[\alpha]_D$ −59.5° and +62.6° (neat), M. C. Berlak and W. Gerrard, *J. Chem. Soc.*, 2309 (1949). [d] Contained 15–20% of THF formed as an azeotropic mixture. [e] Based on highest values reported: **3-methylpentanoic acid,** $[\alpha]_D$ −8.92° (neat), P. A. Levene and R. E. Marker, *J. Biol. Chem.*, **92,** 456 (1931); **3-methylhexanoic acid,** $[\alpha]_D$ +2.50° (neat), I. A. Holiday and N. Polgar, *J. Chem. Soc.*, 2934 (1957), and $[\alpha]_D$ +2.77° (neat), P. A. Levene and R. E. Marker, *J. Biol. Chem.*, **92,** 456 (1931). [f] Contained 6–8% octenes which accounted for the lower value as compared to the corresponding acid. [g] **3-Methylnonanoic acid** is reported to have $[\alpha]_D$ −4.71° (neat), A. Rothen and P. A. Levene, *J. Chem. Phys.*, **7,** 975 (1939). Optical purity is based on +7.1° obtained in this work.