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Tethered Silanoxyiodination of Alkenes

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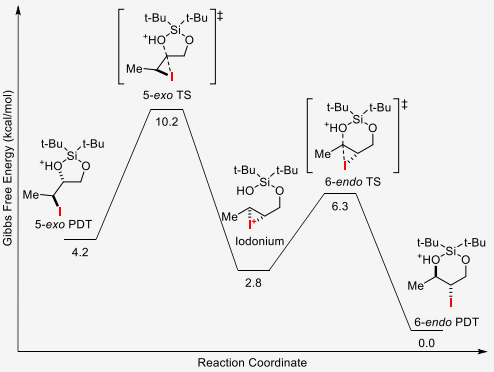
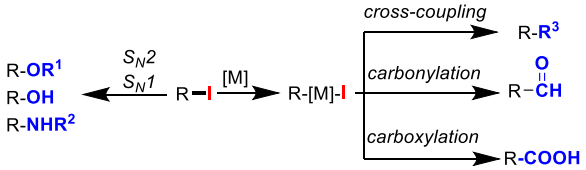
ABSTRACT: We present the first examples of tethered silanoxyiodination reactions of allylic alcohols. The products are useful silanediol organoiodide synthons and are formed with high regioselectivity and diastereocontrol. The reaction is scalable greater than 10-fold without loss of yield or selectivity. Furthermore, the products are starting materials for further transformations, including deiodination, C−N bond installation, epoxide synthesis, and desilylation. DFT calculations provide a basis for understanding the exquisite 6-*endo* selectivity of this silanoxyiodination reaction and show that the observed products are both kinetically and thermodynamically preferred.



Tethered alkene functionalization reactions allow the synthetic chemist to transform olefins with unusual precision.[1−7] Because of the predisposition for six- and seven-membered cyclic transition states, one can simply count the number of atoms from the nucleophilic auxiliary ("the tether") where the functionalization event is likely to take place; due to geometric constraints, these reactions generally proceed with high regio- and diastereoselectivity. Our laboratory is deeply invested in developing tethered olefin functionalization reactions, and we have disclosed such reactions using sulfamate,[8,9] phosphoramidate,[10] and di-*tert*-butylsilanoxy tethers.[11,12]

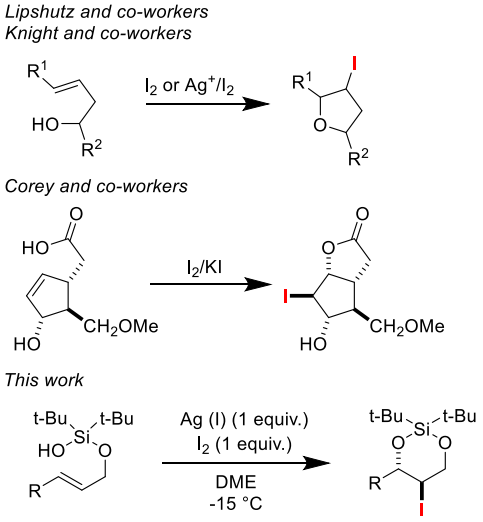
Iodofunctionalization of olefins is a particularly powerful method for the synthesis of organoiodides, which are versatile precursors for C−O,[13] C−N,[14] and C−C bonds[15] (Scheme 1).

Scheme 1. Organoiodides Have Proven Versatility



Two particularly well-known classes within this large area are iodolactonization[16−20] and iodoetherification[21−24] of olefins (Scheme 2), and examples of both are found in complex molecule syntheses. Building on this precedent, we imagined a silanoxyiodination reaction that would yield protected diol iodides in a single step and with high regio- and diastereoselectivity. We reasoned that the di-*tert*-butyl silyl group could be facilely removed to reveal useful iodo-diol synthons. Here, we describe our efforts to reduce this idea to practice.

Scheme 2. Elegant Work with Iodolactonization and Iodoetherification Inspired This Tethered Silanoxyiodination



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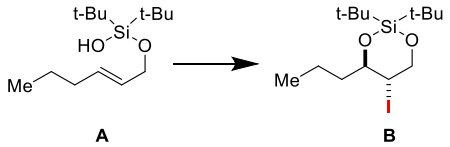
Optimization of this tethered silanoxyiodination reaction began with (*E*)-di-*tert*-butyl(hex-2-en-1-yloxy)silanol, conveniently prepared in one step from commercially available di-*tert*-butylsilyl bis(trifluoromethanesulfonate) and *trans*-2-hexen-1-ol.[11] With I_2 (3 equiv) and $NaHCO_3$ (6 equiv) in acetonitrile at 0 °C, we were pleased to observe 65% of desired product (Table 1, entry 1). However, we soon discovered that these

Table 1. Optimization of a Tethered Silanoxyiodination Reaction



A B

	Ag(I) (equiv)	I_2 (equiv)	solvent	temp[a] (°C)	B/A[b]
1	none	3[c]	MeCN	0	65/0
2	$AgNO_3$ (1)	1	MeCN	0	0/0[d]
3	Ag(TFA) (1)	1	MeCN	0	0/0[e]
4	$AgBF_4$ (1)	1	MeCN	0	58/0
5	$AgBF_4$ (1)	1	THF	0	60/0
6	$AgBF_4$ (1)	1	EtOAc	0	62/11
7	$AgBF_4$ (1)	1	CH_2Cl_2	0	22/0
8	$AgBF_4$ (1)	1	THF	−15	65/0
9	$AgBF_4$ (1)	1	THF	−45	45/0
10	AgOTf (1)	1	THF	−15	70/0
11	$AgBF_4$ (1)	1	DME	−15	75/0
12	AgOTf (1)	1	DME	−15	80/0

[a]Reaction times were between 1 and 2 h in all cases. [b]Yield estimated from ^1H NMR integration with methyl phenyl sulfone as an internal standard. [c]With 6 equiv of $NaHCO_3$. [d]Two noncyclized products, which we presume result from NO_3^- opening of the iodonium intermediate. [e]Two noncyclized products, which we presume result from $CF_3CO_2^-$ opening of the iodonium intermediate.

conditions were much too corrosive with other allylic silanols and led to markedly reduced product yields. The use of Ag (I) in conjunction with I_2 is well-known for the mild generation of I^+.[21,23,25] With $AgNO_3/I_2$ (Table 1, entry 2) and with $Ag(TFA)/I_2$ (Table 1, entry 3) we did not observe any cyclized product formation. In both cases, we isolated linear alkyl iodide products, which we presume result from intermolecular opening of the transient iodonium intermediate by NO_3^- and $CF_3CO_2^-$. We hypothesized that switching to a silver salt with a *non-nucleophilic* counterion would eliminate intermolecular ring-opening. With $AgBF_4$ in acetonitrile, tetrahydrofuran, or ethyl acetate (Table 1, entries 4−6) at 0 °C, we observed ∼60% cyclized product formation. Using CH_2Cl_2 as a solvent was markedly deleterious (Table 1, entry 7). In THF, when the temperature was reduced from 0 to −15 °C, the yield of cyclized product increased slightly (Table 1, entry 8); however, dropping the temperature further to −45 °C led to a dramatic decrease in product formation (Table 1, entry 9). We found that $Ag(OTf)/I_2$ in THF, $Ag(OTf)/I_2$ in DME, and $AgBF_4/I_2$ in DME at −15 °C (Table 1, entries 10−12) all gave comparable, good yields of cyclized product. Overall, we chose three protocols (A: $AgBF_4/I_2$/THF, B: $AgBF_4/I_2$/DME, C: $AgOTf/I_2$/DME) for further exploration of scope.

Examination of a variety of allylic silanol substrates (Scheme 3) with these protocols revealed that this transformation is quite general, tolerant of diverse functional groups, and in most cases proceeds with high regio- and diastereoselectivity. We have determined the relative configuration of one of these products through X-ray diffraction analysis, which establishes that the iodine and the pendant alkyl chain are *trans* to each other (Scheme 3, entry 11, CCDC: 2062814). While protocol A ($AgBF_4/I_2$/THF) gave good product yields with several substrates (Scheme 3, entries 1 and 7), a curious side product complicated crude NMR analysis and purification. Amazingly, this side product has been previously characterized and arises from a ring-opening polymerization of THF by I_2![26] We thus abandoned THF in favor of DME, and we recommend that for substrates not shown here both protocol B ($AgBF_4/I_2$/DME) and protocol C ($AgOTf/I_2$/DME) should be empirically tested for best results. We were pleased to find that a variety of alkyl chains (Scheme 3, entries 1, 2, and 6), rings (Scheme 3, entries 3 and 4), alkyl ethers (Scheme 3, entry 3), ketals (Scheme 3, entry 5), esters (Scheme 3, entry 10), aromatic rings (Scheme 3, entries 8 and 11), and heteroaromatic rings (Scheme 3, entries 9 and 12) were all tolerated by our optimized protocols. Furthermore, we were not limited to disubstituted olefins. A variety of trisubstituted olefins (Scheme 3, entries 13−15) reacted smoothly as well.

We were pleased to see that the reaction scaled greater than 10-fold without loss of yield or selectivity (Scheme 4).

Furthermore, the cyclic silanediol organoiodide products were amenable to a variety of further transformations, including deiodination, nucleophilic azide displacement, epoxide formation, and silicon removal (Scheme 5).

In all cases, we exclusively observed products of 6-*endo*-*trig* cyclization reactions. In order to rationalize such exquisite selectivity for the 6-*endo* product over the 5-*exo* isomer, we turned to DFT calculations using the ORCA software package.[27,28] All calculations were performed using the B3LYP functional[29,30] with D3BJ dispersion correction[31,32] using the RIJCOSX approximation.[33] The def2-TZVP basis set[34] was used, and implicit THF solvation was applied using the SMD model.[35] When iodine was present, the def2-ECP[36] was applied automatically. Counterions were not modeled for ionic species. Further details and atomic coordinates are reported in the Supporting Information.

Upon exposing substrate alkene **1** to molecular iodine, the immediate product is an intermediate iodonium **61**. Intramolecular ring closure can proceed *via* either a 5-*exo* (**62**) or a 6-*endo* (**63**) transition state, leading to isomeric protonated products **64** and **65**. For the 5-*exo* pathway, both the transition state and the cationic product are more than 4 kcal/mol higher in energy than their 6-*endo* counterparts (Figure 1). This overwhelming preference for the 6-*endo* pathway agrees with the experimental absence of any 5-*exo* product, even in trace amounts. The origin of the 6-*endo* selectivity is most likely due to ring strain. For acyclic iodonium **61**, the O−Si−O angle is 102.6°, which is 6.9° lower than the ideal tetrahedral angle of 109.5°. This initial acyclic perturbation is likely due to the presence of the *tert*-butyl groups on the silicon, a manifestation of the Thorpe−Ingold effect.[37] The 6-*endo* transition state **63** has an O−Si−O angle of 101.3° and the 6-*endo* product **65** has an O−Si−O angle of 97.6°, the latter of which is only 5° smaller than the acyclic angle on iodonium **61**. By contrast, the 5-*exo* transition state **62** has an O−Si−O angle of 96.7° and the 5-*exo* product **64** has an O−Si−O angle of 89.8°, the latter of which is now geometrically acute and 12.8° smaller than the acyclic angle on iodonium **61**. Thus, the *tert*-butyl groups on silicon promote a Si−O−Si angle close to that required for 6-

https://doi.org/10.1021/acs.joc.1c00872
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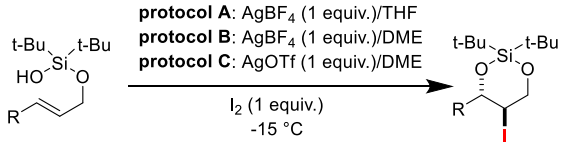
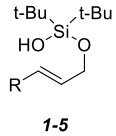
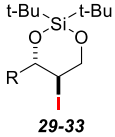
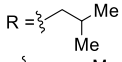
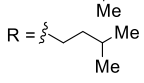
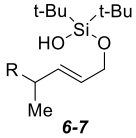
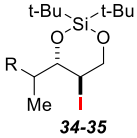
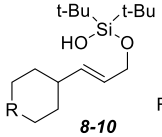
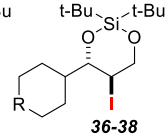
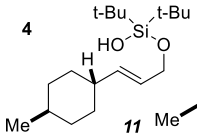
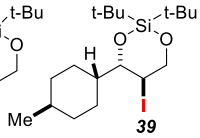
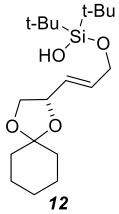
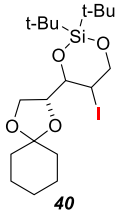
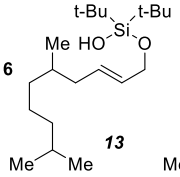
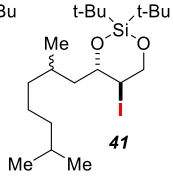
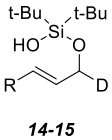
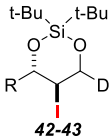
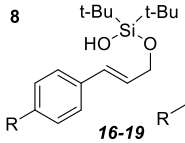
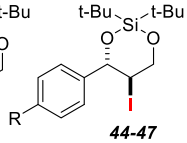
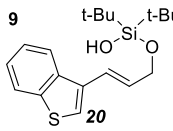
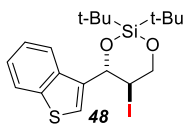
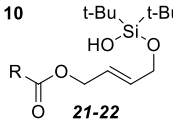
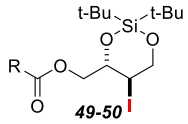
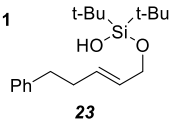
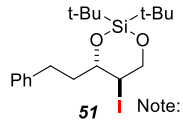
Scheme 3. Substrate Scope



entry	substrate	product	protocol		yield
1	 1-5	 29-33	C	R = Me	92%
			A	R = C_3H_7	70%
			A	R = C_9H_{19}	68%
			B	R = 	65%
			B	R = 	89%
2	 6-7	 34-35	B	R = Me	58%
			B	R = Et	48% dr = 1:1
3	 8-10	 36-38	B	R = CH_2	70%
			B	R = O	75%
			B	R = NBoc	48%
4	 11	 39	B		72%
5	 12	 40	B		35%
6	 13	 41	C		65% dr = 1:1
7	 14-15	 42-43	A	R = Et	62%
			B	R = C_6H_{13}	67%
8	 16-19	 44-47	C	R = H	79%
			C	R = F	70%
			B	R = Br	80%
			C	R = 	50%

entry	substrate	product	protocol	yield
9	 20	 48	C	39%
10	 21-22	 49-50	B R = Me	72%
			B R = Ph	36%
11	 23	 51	B	77%
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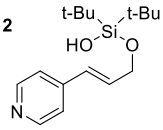
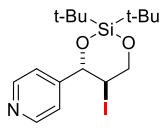
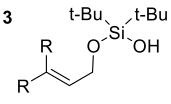
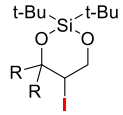
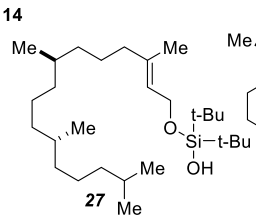
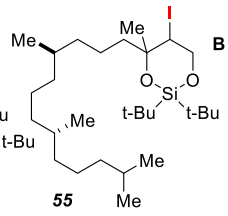
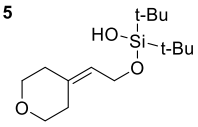
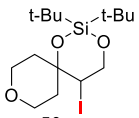
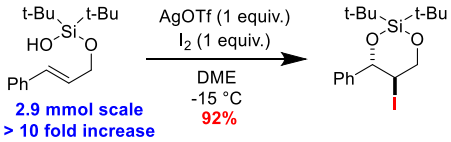
12	 24	 52	C	50%
13	 25-26	 53-54	B R = Me	80%
			B R = Et	59%
14	 27	 55	B	70%
15	 28	 56	B	44%

Scheme 4. Silanoxyiodination Scales Greater than 10-Fold without Loss of Yield or Selectivity



endo ring closure, while 5-*exo* ring closure requires a much more strained and energetically unfavorable Si−O−Si angle.

In summary, we present the first examples of tethered silanoxyiodination reactions of allylic alcohols. The products are useful silanediol organoiodide synthons and are formed with high regioselectivity and diastereocontrol. The reaction is scalable greater than 10-fold without loss of yield or selectivity. Furthermore, the products are starting materials for further

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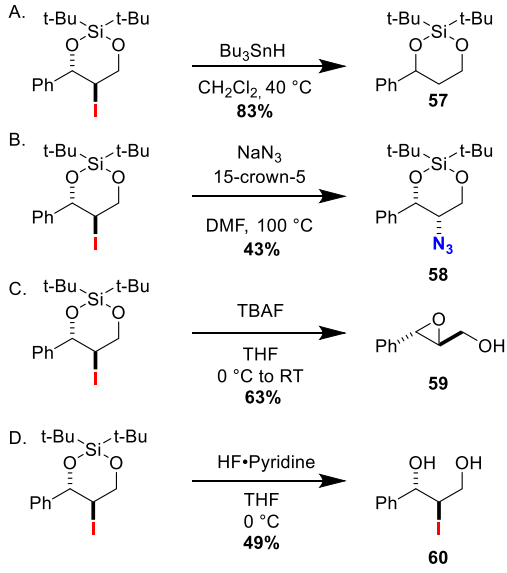
Scheme 5. Products Are Versatile Synthons for (A) Deiodination, (B) C−N Bond Formation, (C) Epoxide Formation, and (D) Silicon Removal



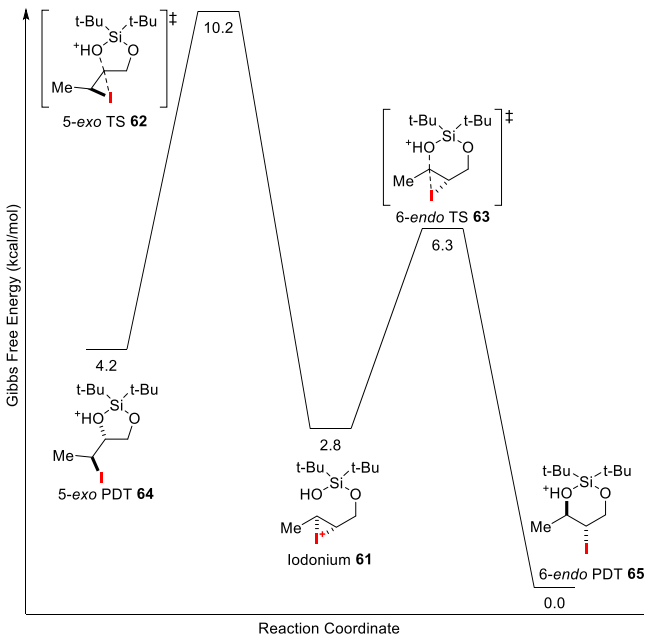


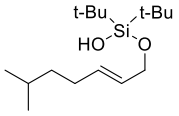
Figure 1. DFT energies for cationic iodonium rearrangements of substrate **1**.

transformations, including deiodination, C−N bond installation, epoxide synthesis, and desilylation. DFT calculations provide a basis for understanding the exquisite 6-*endo* selectivity of this silanoxyiodination reaction. We expect this reaction to find much use in the construction of complex molecules containing functional group stereochemical arrays.

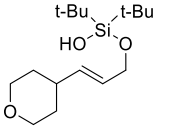
EXPERIMENTAL SECTION

I. General Considerations. All reagents were obtained commercially unless otherwise noted. Solvents were purified by passage under 10 psi N_2 through activated alumina columns. Infrared (IR) spectra were recorded on a Thermo Scientific Nicolet iS5 FT-IR spectrometer; data are reported in frequency of absorption (cm^{-1}). NMR spectra were recorded on a Bruker Avance 400 operating at 400 and 100 MHz. ^1H NMR spectra were recorded at 400 MHz. Data are recorded as chemical shift in ppm referenced internally using residue solvent peaks, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet or overlap of nonequivalent resonances), integration, and coupling constant (Hz). ^{13}C NMR spectra were recorded at 100 MHz. Exact mass spectra were recorded using an electrospray ion source (ESI) either in positive mode or negative mode with a time-of-flight (TOF) analyzer on a Waters LCT PremierTM mass spectrometer and are given in *m*/*z*. TLC was performed on precoated glass plates (Merck) and visualized either with a UV lamp (254 nm) or by dipping into a solution of $KMnO_4$−K_2CO_3 in water followed by heating. Flash chromatography was performed on silica gel (230−400 mesh) or Florisil (60−100 mesh).

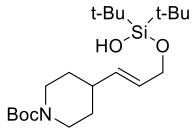
II. Characterization of Previously Unreported Substrates. Note 1: Substrates were synthesized according to previously reported procedures.[11] Note 2: Compounds **1**−**4**, **6**−**8**, **11**, **13**−**17**, **19**, **20**, **23**, and **25** have been reported previously.[11,12].



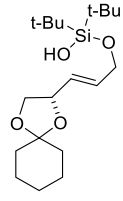
*(E)-Di-tert-butyl((6-methylhept-2-en-1-yl)oxy)silanol (**5**).* Purified using a gradient of 0−10% EtOAc in hexanes on silica gel (yellow oil, 476 mg, 83%); ^1H NMR (400 MHz, chloroform-*d*) δ 5.69 (ddt, *J* = 14.1, 6.2, 1.2 Hz, 1H), 5.59 (dtt, *J* = 15.3, 5.3, 1.2 Hz, 1H), 4.35−4.28 (m, 2H), 2.12−2.01 (m, 2H), 1.58 (dq, *J* = 13.3, 6.7 Hz, 1H), 1.33−1.24 (m, 2H), 1.05 (s, 18H), 0.91 (d, *J* = 6.6 Hz, 6H); $^{13}C\{^1H\}$ NMR (101 MHz, chloroform-*d*) δ 131.6, 129.1, 64.2, 38.4, 30.0, 27.5, 27.42, 22.47, 20.46; IR 2857, 1457, 1173 cm^{-1}; HRMS (ESI) calcd for $C_{16}H_{33}O_2Si^-$ 285.2250, found 285.2245 (M^-).



*(E)-Di-tert-butyl((3-(tetrahydro-2H-pyran-4-yl)allyl)oxy)silanol (**9**).* Purified using a gradient of 0 to 50% acetone/DCM; (light yellow oil, 403 mg, 67% yield); ^1H NMR (400 MHz, $CDCl_3$) δ 5.63−5.54 (m, 1H), 5.54−5.42 (m, 1H), 4.24 (tt, *J* = 4.8, 1.2 Hz, 2H), 3.89 (ddt, *J* = 12.5, 4.2, 1.6 Hz, 2H), 3.35 (tt, *J* = 11.6, 2.2 Hz, 2H), 2.20−2.12 (m, 1H), 1.55 (ddq, *J* = 12.8, 4.1, 2.0 Hz, 2H), 1.46−1.30 (m, 2H), 0.95 (s, 18H); $^{13}C\{^1H\}$ NMR (101 MHz, $CDCl_3$) δ 134.8, 134.4, 127.9, 127.6, 67.7, 64.1, 63.9, 37.3, 32.6, 32.5, 27.8, 27.4, 21.2, 20.4; IR 2933, 1473, 1127, 827, 648 cm^{-1}; HRMS (ESI) calcd for $C_{16}H_{31}O_3Si^-$ 299.2048, found 299.2055 (M^-).



*tert-Butyl (E)-4-(3-((di-tert-butyl(hydroxy)silyl)oxy)prop-1-en-1-yl)piperidine-1-carboxylate (**10**).* Purified using a gradient of 0−10% EtOAc in hexanes on silica gel (colorless oil, 663 mg, 83%); ^1H NMR (400 MHz, chloroform-*d*) δ 5.70−5.55 (m, 2H), 4.33 (dd, *J* = 4.8, 1.2 Hz, 2H), 4.11 (dt, *J* = 13.7, 3.6 Hz, 2H), 2.76 (ddd, *J* = 13.3, 12.2, 2.8 Hz, 2H), 2.14 (td, *J* = 10.8, 5.9 Hz, 1H), 1.74−1.65 (m, 2H), 1.48 (s, 9H), 1.37−1.25 (m, 2H), 1.05 (s, 18H); $^{13}C\{^1H\}$ NMR (101 MHz, chloroform-*d*) δ 154.9, 134.6, 128.0, 79.3, 63.9, 43.6, 38.4, 31.7, 28.4, 27.4, 20.4; IR 2857, 1457, 1173 cm^{-1}; HRMS (ESI) calcd for $C_{21}H_{41}NO_4SiNa^+$ 422.2703, found mass 422.2692 (MNa^+).



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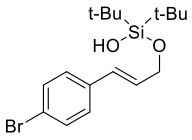
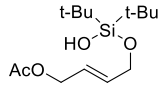
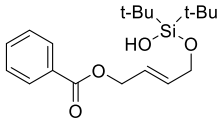
*(S,E)-((3-(1,4-Dioxaspiro[4.5]decan-2-yl)allyl)oxy)di-tert-butylsilanol (**12**).* Purified using a gradient of 0−20% EtOAc/hexanes (colorless oil, 420 mg, 59% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.92 (dtd, J = 15.3, 4.5, 0.9 Hz, 1H), 5.75 (ddt, J = 15.4, 7.4, 1.7 Hz, 1H), 4.62−4.50 (m, 1H), 4.39 (ddd, J = 4.5, 1.7, 0.7 Hz, 2H), 4.14−4.09 (m, 1H), 3.68−3.53 (m, 1H), 1.72−1.58 (m, 9H), 1.43 (m, 1H), 1.05 (s, 18H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 133.4, 127.4, 109.8, 76.2, 69.1, 63.0, 36.2, 35.4, 27.4, 25.1, 23.9, 23.8, 20.5; IR 2866, 1465, 1082, 829 cm^{-1}; HRMS (ESI) calcd for $C_{19}H_{35}O_4Si^-$ 355.2310, found 355.2336 (M^-).



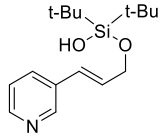
*(E)-((3-(4-Bromophenyl)allyl)oxy)di-tert-butylsilanol (**18**).* Purified using a gradient of 0−0.2% acetone in DCM (light yellow oil, 319 mg, 43% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57−7.40 (m, 2H), 7.40−7.16 (m, 2H), 6.61 (dt, J = 15.9, 2.0 Hz, 1H), 6.33 (dt, J = 15.8, 4.9 Hz, 1H), 4.55 (dd, J = 4.9, 1.8 Hz, 2H), 1.09 (d, J = 0.9 Hz, 18H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 136.2, 131.7, 130.1, 128.2, 128.0, 121.1, 63.9, 27.5, 20.6; IR 3471, 2919, 1479, 1378, 829 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{26}BrO_2Si^-$ 369.0891, found 369.0867 (M^-).



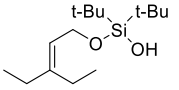
*(E)-4-((Di-tert-butyl(hydroxy)silyl)oxy)but-2-en-1-yl acetate (**21**).* Purified using a gradient of 0−50% acetone in DCM on silica gel followed by a gradient of 0 to 100% acetonitrile in 0.1%TFA/H_2O on a RediSep Prep C18 column (100 Å, 5 μm, Length 250 mm i.d.: 20 mm, flow rate of 15 mL/min) (light yellow oil, 288 mg, 50% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.96−5.78 (m, 2H), 4.67−4.56 (m, 2H), 4.40 (dt, J = 4.0, 1.3 Hz, 2H), 2.10 (s, 3H), 1.06 (s, 18H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 171.1, 134.2, 123.3, 64.6, 63.0, 27.4, 20.9, 20.5; IR 3442, 2947, 1730, 1246, 829 cm^{-1}; HRMS (ESI) calcd for $C_{14}H_{27}O_4Si^-$ 287.1684, found 287.1661 (M^-).



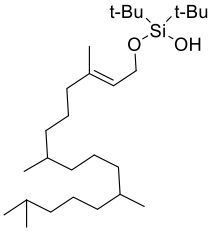
*(E)-4-((Di-tert-butyl(hydroxy)silyl)oxy)but-2-en-1-yl benzoate (**22**).* Purified using a gradient of 0−50% acetone/DCM on silica gel (light yellow semisolid, 343 mg, 49% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09−7.98 (m, 2H), 7.60−7.53 (m, 1H), 7.44 (ddd, J = 8.2, 6.7, 1.2 Hz, 2H), 6.03−5.88 (m, 2H), 4.83 (tt, J = 2.3, 1.3 Hz, 2H), 4.40 (p, J = 1.4 Hz, 2H), 1.03 (s, 18H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 166.6, 134.2, 133.0, 130.3, 129.7, 128.4, 123.7, 65.0, 63.2, 27.5, 20.6; IR 3447, 2933, 1704, 1279, 827 cm^{-1}; HRMS (ESI) calcd for $C_{19}H_{29}O_4Si^-$ 349.1841, found 349.1813 (M^-).



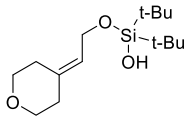
*(E)-Di-tert-butyl((3-(pyridin-3-yl)allyl)oxy)silanol (**24**).* Purified using a gradient of 0−10% EtOAc in hexanes on silica gel (colorless oil, 411 mg, 70%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 8.60 (d, J = 2.2 Hz, 1H), 8.47 (dd, J = 4.9, 1.6 Hz, 1H), 7.71 (dt, J = 7.9, 1.9 Hz, 1H), 7.27 (dd, J = 7.9, 4.9 Hz, 1H), 6.65 (dd, J = 15.9, 1.8 Hz, 1H), 6.40 (ddd, J = 16.0, 5.1, 4.2 Hz, 1H), 4.58 (dd, J = 4.7, 1.9 Hz, 2H), 1.10 (s, 18H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 148.0, 147.9, 133.0, 132.9, 131.9, 125.3, 123.5, 63.6, 27.4, 20.5; IR 2856, 1471, 1134 cm^{-1}; HRMS (ESI) calcd for $C_{16}H_{28}NO_2Si^+$ 294.1884 found 294.1852 (MH^+).



*Di-tert-butyl((3-ethylpent-2-en-1-yl)oxy)silanol (**26**).* Purified using a gradient of 0−10% EtOAc in hexanes on silica gel (colorless oil, 409 mg, 75%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 5.32 (td, J = 6.5, 3.3 Hz, 1H), 4.40 (dd, J = 6.3, 1.2 Hz, 2H), 2.13−2.01 (m, 4H), 1.08−0.97 (m, 6H),1.05 (s, 18H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 144.6, 122.7, 60.1, 28.9, 27.4, 23.6, 20.4, 13.3, 12.5; IR 2933, 1471, 1107 cm^{-1}; HRMS (ESI) calcd for $C_{15}H_{31}O_2Si^-$ 271.2093 found 271.2091 (M^-).



*(E)-Di-tert-butyl((3,7,11,15-tetramethylhexadec-2-en-1-yl)oxy)-silanol (**27**).* Purified using a gradient of 0−0.1% acetone in DCM (colorless oil, 400 mg, 44% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.37 (tq, J = 6.3, 1.3 Hz, 1H), 4.39 (dq, J = 6.4, 0.9 Hz, 2H), 2.05−1.96 (m, 2H), 1.65 (t, J = 0.8 Hz, 3H), 1.56 (dp, J = 13.3, 6.6 Hz, 1H), 1.49−1.08 (m, 18H), 1.05 (s, 18H), 0.89 (ddd, J = 8.5, 6.6, 0.7 Hz, 12H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 137.4, 124.3, 60.4, 39.8, 39.3, 37.4, 37.4, 37.3, 36.6, 32.8, 32.7, 27.9, 27.4, 25.1, 24.8, 24.4, 22.7, 22.6, 20.4, 19.7, 19.7, 16.2; IR 2928, 1471, 1364, 1099, 827 cm^{-1}; HRMS (ESI) calcd for $C_{28}H_{58}NaO_2Si^+$ 477.4098, found 477.4067 (MNa^+).



*Di-tert-butyl(2-(tetrahydro-4H-pyran-4-ylidene)ethoxy)silanol (**28**).* Purified using a gradient of 0−10% EtOAc in hexanes on silica gel (colorless oil, 401 mg, 70%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 5.44 (tt, J = 6.6, 1.3 Hz, 1H), 4.39 (d, J = 6.5 Hz, 2H), 3.71 (dt, J = 13.3, 5.5 Hz, 4H), 2.36−2.29 (m, 2H), 2.29−2.22 (m, 2H), 1.98 (s, 1H), 1.05 (s, 18H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 136.3, 123.1, 69.4, 68.5, 59.1, 36.6, 29.9, 27.3, 20.4; IR 2933, 1471, 1107 cm^{-1}; HRMS (ESI) calcd for $C_{15}H_{30}O_3SiNa^+$ 309.1856 found 309.1821 (MNa^+).

III. General Protocols for Silanoxyiodination of Alkenes. *Protocol A.* A microwave vial was charged with stir bar, alkene substrate (0.2 mmol, 1 equiv), $AgBF_4$ (39 mg, 0.2 mmol, 1 equiv), and 2 mL of anhydrous THF. The reaction vial was immersed in a bath set to −15 °C. I_2 (51 mg, 0.2 mmol, 1 equiv) was added in one portion. A light yellow precipitate formed immediately upon addition of $AgBF_4$. The heterogeneous mixture was stirred for 1 h at −15 °C and then quenched by addition of aqueous saturated $Na_2S_2O_3$. The reaction mixture was diluted with ethyl acetate and transferred to a separatory funnel. The organic portion was collected, and the aqueous layer was extracted with two additional portions of ethyl acetate. The organic fractions were pooled, dried with $MgSO_4$, and concentrated under reduced pressure. The resulting residue was purified by chromatography on Florisil (specific conditions are associated with each compound).

Protocol B. A microwave vial was charged with stir bar, alkene substrate (0.2 mmol, 1 equiv), $AgBF_4$ (39 mg, 0.2 mmol, 1 equiv), and 2 mL of anhydrous DME. The reaction vial was immersed in a bath set to −15 °C. I_2 (51 mg, 0.2 mmol, 1 equiv) was added in one portion. A light-yellow precipitate formed immediately upon addition of $AgBF_4$. The heterogeneous mixture was stirred for 1 h at −15 °C and then quenched by addition of aqueous saturated $Na_2S_2O_3$. The reaction mixture was diluted with ethyl acetate and transferred to a separatory funnel. The organic portion was collected, and the aqueous layer was extracted with two additional portions of ethyl acetate. The

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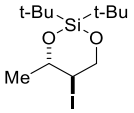
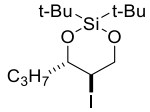
organic fractions were pooled, dried with $MgSO_4$, and concentrated under reduced pressure. The resulting residue was purified by chromatography on Florisil (specific conditions are associated with each compound).

Protocol C. A microwave vial was charged with stir bar, alkene substrate (0.2 mmol, 1 equiv), AgOTf (51 mg, 0.2 mmol, 1 equiv), and 2 mL of anhydrous DME. The reaction vial was immersed in a bath set to −15 °C. I_2 (51 mg, 0.2 mmol, 1 equiv) was added in one portion. A light-yellow precipitate formed immediately upon addition of AgOTf. The heterogeneous mixture was stirred for 1 h at −15 °C and then quenched by addition of aqueous saturated $Na_2S_2O_3$. The reaction mixture was diluted with ethyl acetate and transferred to a separatory funnel. The organic portion was collected, and the aqueous layer was extracted with two additional portions of ethyl acetate. The organic fractions were pooled, dried with $MgSO_4$, and concentrated under reduced pressure. The resulting residue was purified by chromatography on Florisil (specific conditions are associated with each compound).

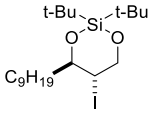
IV. Characterization of Iodinated Products.



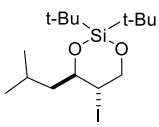
*2,2-Di-tert-butyl-5-iodo-4-methyl-1,3,2-dioxasilinane (**29**).* Synthesized using protocol C; single diastereomer; purified using benzene on Florisil (light yellow semisolid, 66 mg, 92% isolated yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.31 (dq, J = 10.2, 6.0 Hz, 1H), 4.27−4.16 (m, 2H), 4.01 (td, J = 10.5, 5.2 Hz, 1H), 1.53 (d, J = 6.0 Hz, 3H), 1.07 (s, 9H), 1.01 (s, 9H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 75.7, 71.0, 34.2, 27.4, 26.9, 24.8, 22.7, 19.8; IR 2960, 1474, 1136, 825 cm^{-1}; HRMS (ESI) calcd for $C_{12}H_{26}IO_2Si^+$ 357.0741, found 357.0740 (MH^+).



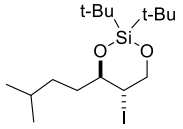
*2,2-Di-tert-butyl-5-iodo-4-propyl-1,3,2-dioxasilinane (**30**).* Synthesized using protocol A; single diastereomer; light yellow solid; purified using a gradient of 0−10% EtOAc in hexanes on silica gel; 54 mg, 70% isolated yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.20−4.09 (m, 2H), 4.05 (ddd, J = 10.2, 8.0, 2.2 Hz, 1H), 3.98 (td, J = 10.4, 4.9 Hz, 1H), 2.02−1.91 (m, 1H), 1.52−1.32 (m, 3H), 0.97 (s, 9H), 0.91 (s, 9H), 0.88 (t, J = 7.2 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 78.3, 71.3, 39.8, 33.2, 27.4, 26.9, 22.8, 19.9, 17.9, 13.7; IR 2960, 1474, 1135, 825 cm^{-1}; HRMS (ESI) calcd for $C_{14}H_{30}IO_2Si^+$ 385.1054, found 385.1057 (MH^+).



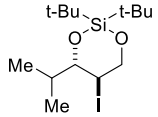
*2,2-Di-tert-butyl-5-iodo-4-nonyl-1,3,2-dioxasilinane (**31**).* Synthesized using protocol A; single diastereomer; purified using benzene on Florisil (colorless oil, 64 mg, 68% isolated yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.20−4.08 (m, 2H), 4.08−3.93 (m, 2H), 2.04−1.92 (m, 1H), 1.50−1.14 (m, 15H), 0.97 (s, 9H), 0.92 (s, 9H), 0.85−0.77 (m, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 78.5, 71.3, 37.6, 33.3, 31.9, 29.5, 29.3, 29.1, 27.4, 26.9, 24.5, 22.8, 22.7, 19.9, 14.1; IR 2927, 1473, 1133, 825 cm^{-1}; HRMS (ESI) calcd for $C_{20}H_{42}IO_2Si^+$ 469.1993, found 469.1993 (MH^+).



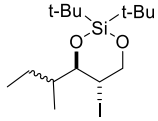
*(±)-2,2-Di-tert-butyl-5-iodo-4-isobutyl-1,3,2-dioxasilinane (**32**).* Synthesized using protocol B; single diastereomer; purified using 100% benzene on Florisil (colorless oil, 52 mg, 65%); ^{1}H NMR (400 MHz, chloroform-d) δ 4.28−4.12 (m, 3H), 3.97−4.05 (m, 1H), 2.00−1.84 (m, 2H), 1.44−1.37 (m, 1H), 1.05 (s, 9H), 0.99 (s, 9H), 0.96 (d, J = 6.5 Hz, 3H), 0.94 (d, J = 6.3 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-d) δ 77.2, 71.2, 46.8, 34.1, 27.4, 26.9, 24.3, 23.7, 22.8, 21.1, 19.8; IR 2957, 1364, 903 cm^{-1}; HRMS (ESI) calcd for $C_{15}H_{32}IO_2Si^+$ 399.1216, found 399.1253 (MH^+).



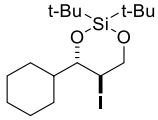
*2,2-Di-tert-butyl-5-iodo-4-isopentyl-1,3,2-dioxasilinane (**33**).* Synthesized using protocol B; purified using 100% benzene on Florisil; single diastereomer (colorless oil, 73 mg, 89%); ^{1}H NMR (400 MHz, chloroform-d) δ 4.29−4.02 (m, 4H), 2.14−2.04 (m, 1H), 1.63−1.46 (m, 2H), 1.43−1.26 (m, 2H), 1.05 (s, 9H), 1.00 (s, 9H), 0.93 (d, J = 4.9 Hz, 3H), 0.91 (d, J = 4.8 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-d) δ 78.7, 71.2, 35.4, 33.6, 33.3, 27.6, 27.4, 26.9, 23.0, 22.8, 22.2, 19.9; IR 2956, 1137, 896 cm^{-1}; HRMS (ESI) calcd for $C_{16}H_{34}IO_2Si^+$ 413.1373, found 413.1370 (MH^+).



*2,2-Di-tert-butyl-5-iodo-4-isopropyl-1,3,2-dioxasilinane (**34**).* Synthesized using protocol B; purified using benzene on Florisil (light yellow semisolid, 45 mg, 58% isolated yield); single diastereomer; ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.32 (dd, J = 10.4, 4.2 Hz, 1H), 4.24 (t, J = 10.7 Hz, 1H), 4.21−4.12 (m, 1H), 4.02 (dd, J = 10.1, 2.0 Hz, 1H), 2.34 (pd, J = 6.8, 2.0 Hz, 1H), 1.07 (s, 9H), 1.04 (d, J = 6.4 Hz, 12H), 0.87 (d, J = 6.7 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 81.7, 71.8, 33.0, 31.8, 27.6, 26.9, 23.0, 20.2, 20.0, 13.2; IR 2960, 1076, 1028, 764 cm^{-1}; HRMS (ESI) calcd for $C_{14}H_{30}IO_2Si^+$ 385.1060, found 385.1052 (MH^+).



*(±) 4-sec-Butyl-2,2-di-tert-butyl-5-iodo-1,3,2-dioxasilinane (**35**).* Synthesized using protocol B; purified using 100% benzene on Florisil; ∼1:1 mixture of diastereomers (colorless oil, 38 mg, 48%); ^{1}H NMR (400 MHz, chloroform-d) δ 4.36−4.27 (m, 1H), 4.27−4.14 (m, 2H), 4.08−4.00 (m, 1H), 2.07 (dddd, J = 18.4, 8.8, 5.1, 1.9 Hz, 1H), 1.56−1.46 (m, 1H), 1.46−1.34 (m, 1H), 1.24−1.14 (m, 1H), 1.07 (s, 4H), 1.06 (s, 5H), 1.04 (s, 1H), 1.03 (s, 4H), 1.02 (s, 5H), 0.97 (m, 3H), 0.87 (d, J = 6.7 Hz, 1H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-d) δ 82.6, 79.8, 71.9, 71.8, 39.8, 39.7, 31.6, 31.5, 27.6, 27.5, 27.0, 26.9, 26.8, 23.0, 20.4, 20.2, 16.5, 12.0, 11.7, 11.4; IR 2859, 1474, 939 cm^{-1}; HRMS (ESI) calcd for $C_{15}H_{32}IO_2Si^+$ 399.1216, found 399.1161 (MH^+).



*2,2-Di-tert-butyl-4-cyclohexyl-5-iodo-1,3,2-dioxasilinane (**36**).* Synthesized using protocol B; purified using benzene on Florisil (colorless semisolid, 59 mg, 70% isolated yield); single diastereomer; ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.34−4.17 (m, 3H), 3.98 (dt, J = 8.1, 2.1 Hz, 1H), 2.00 (td, J = 5.3, 2.5 Hz, 1H), 1.86−1.74 (m, 2H), 1.70 (dt, J = 12.6, 2.8 Hz, 1H), 1.59 (dd, J = 8.4, 3.2 Hz, 1H), 1.53 (td, J = 9.4, 3.4 Hz, 2H), 1.40−1.12 (m, 4H), 1.06 (s, 9H), 1.03 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 81.6, 71.8, 43.5, 31.1, 30.2, 27.6, 27.0, 26.5, 26.4, 26.0, 23.8, 23.0, 20.2; IR 2930, 1072, 1001, 975 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{34}IO_2Si^+$ 425.1367, found 425.1358 (MH^+).

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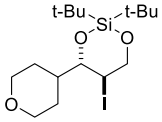
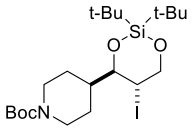
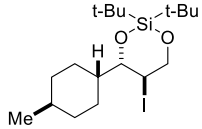


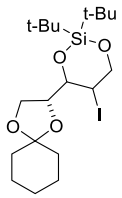
*2,2-Di-tert-butyl-5-iodo-4-(tetrahydro-2H-pyran-4-yl)-1,3,2dioxasilinane (**37**).* Synthesized using protocol B; purified using a gradient of 0−40% EtOAc/benzene on Florisil; single diastereomer (light yellow oil, 64 mg, 75% isolated yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.23 (dd, J = 10.1, 3.9 Hz, 1H), 4.19−4.03 (m, 2H), 4.01−3.90 (m, 3H), 3.43−3.27 (m, 2H), 2.17 (ttd, J = 11.8, 3.7, 2.0 Hz, 1H), 1.92−1.79 (m, 1H), 1.66−1.52 (m, 1H), 1.32 (dddt, J = 13.3, 11.5, 3.8, 2.1 Hz, 2H), 0.98 (s, 9H), 0.93 (s, 9H). ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 80.5, 71.6, 68.0, 67.7, 40.5, 30.1, 29.5, 27.6, 26.9, 23.9, 23.0, 20.2; IR 2857, 1163, 1080, 825 cm^{-1}; HRMS (ESI) calcd for $C_{16}H_{32}IO_3Si^+$ 427.1166, found 427.1162 (MH^+).



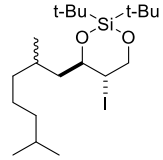
*2,2-Di-tert-butyl-5-iodo-1,3,2-dioxasilinan-4-yl)piperidine-1-carboxylate (**38**).* Synthesized using protocol B; purified using 100% benzene on Florisil; single diastereomer (colorless oil, 51 mg, 48%); ^{1}H NMR (400 MHz, chloroform-d) δ 4.32−4.10 (m, 5H), 4.02 (dd, J = 10.1, 2.0 Hz, 1H), 2.70 (dd, J = 25.1, 13.4 Hz, 2H), 2.12 (ddddd, J = 13.6, 11.6, 9.7, 4.9, 2.0 Hz, 1H), 1.68 (dd, J = 28.2, 13.7 Hz, 1H), 1.52−1.45 (m, 3H), 1.47 (s, 9H), 1.03 (s, 9H), 0.98 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-d) δ 154.9, 80.5, 79.3, 71.6, 43.9, 41.4, 30.3, 28.4, 27.5, 26.9, 23.0, 22.9, 20.1; IR 2933, 1423, 923 cm^{-1}; HRMS (ESI) calcd for $C_{21}H_{41}INO_4Si^+$ 526.1850, found 526.1891 (MH^+).



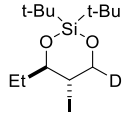
*2,2-Di-tert-butyl-5-iodo-4-methylcyclohexyl)-1,3,2-dioxasilinane (**39**).* Synthesized using protocol B; purified using benzene on Florisil; single diastereomer (colorless oil, 63 mg, 72% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.24−4.09 (m, 3H), 3.91 (dt, J = 8.8, 2.0 Hz, 1H), 1.88−1.78 (m, 1H), 1.67 (ddt, J = 13.6, 5.9, 1.9 Hz, 2H), 1.54−1.40 (m, 3H), 1.19 (dtt, J = 12.2, 9.0, 5.6 Hz, 3H), 0.96 (s, 9H), 0.92 (s, 9H), 0.94−0.84 (m, 1H), 0.81 (d, J = 6.5 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 81.3, 71.8, 42.5, 35.0, 34.6, 32.7, 31.3, 30.0, 27.6, 27.0, 23.5, 23.0, 22.6, 20.2; IR 2928, 1455, 1117, 825 cm^{-1}; HRMS (ESI) calcd for $C_{18}H_{36}IO_2Si^+$ 439.1524, found 439.1516 (MH^+).



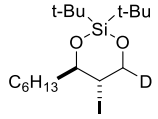
*2,2-Di-tert-butyl-5-iodo-4-((R)-1,4 dioxaspiro[4.5]decan-2-yl)-1,3,2-dioxasilinane (**40**).* Synthesized using protocol B; purified using a gradient of 0 to 5% EtOAc/hexanes on Florisil; single diastereomer (colorless oil, 34 mg, 35% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.45 (td, J = 6.7, 3.6 Hz, 1H), 4.30 (dd, J = 10.7, 3.6 Hz, 1H), 4.22−4.10 (m, 2H), 4.00−3.92 (m, 2H), 3.81 (td, J = 10.6, 5.2 Hz, 1H), 1.72−1.61 (m, 1H), 1.61−1.46 (m, 7H), 1.33 (s, 2H), 0.99 (s, 9H), 0.93 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 110.3, 79.2, 77.5, 71.6, 63.7, 35.7, 35.6, 27.5, 26.9, 26.4, 25.2, 24.0, 23.8, 23.0, 20.1; IR 2933, 1110, 1058, 825 cm^{-1}; HRMS calculated for $C_{19}H_{36}IO_4Si^+$ 483.1422, found 483.1414 (MH^+).



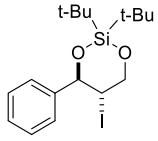
*2,2-Di-tert-butyl-4-(2,6-dimethylheptyl)-5-iodo-1,3,2-dioxasilinane (**41**).* Synthesized using protocol C; purified using 100% benzene on Florisil; ∼1:1 mixture of diastereomers (colorless oil, 61 mg, 65%); ^{1}H NMR (400 MHz, chloroform-d) δ 4.29−4.15 (m, 3H), 4.06−3.99 (m, 1H), 2.03 (ddd, J = 13.6, 8.9, 2.1 Hz, 1.4H), 1.87−1.76 (m, 0.6H), 1.60−1.50 (m, 1H), 1.47−1.37 (m, 1H), 1.37−1.31 (m, 1H), 1.30−1.22 (m, 2H), 1.20−1.13 (m, 2H), 1.12−1.07 (m, 1H), 1.05 (s, 9H), 0.99 (s, 9H), 0.95 (d, J = 6.8 Hz, 1.8H), 0.92 (d, J = 6.2 Hz, 1.2H), 0.89 (d, J = 1.2 Hz, 3H), 0.87 (d, J = 1.0 Hz, 3H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-d) δ 71.2, 71.2, 45.2, 44.7, 39.3, 39.1, 37.9, 35.6, 34.3, 29.3, 28.7, 27.9, 27.9, 27.44, 27.42, 26.9, 24.7, 24.4, 22.84, 22.81, 22.74, 22.70, 22.66, 22.59, 20.7, 19.8, 19.0; IR 2859, 1474, 906 cm^{-1}; HRMS (ESI) calcd for $C_{20}H_{42}IO_2Si^+$ 469.1999, found 469.2005 (MH^+).



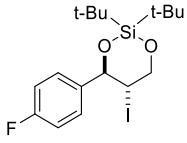
*2,2-Di-tert-butyl-4-ethyl-5-iodo-1,3,2-dioxasilinane-6-d (**42**).* Synthesized using protocol A; purified using benzene on Florisil followed by eluting with 20% EtOAc/hexanes on a small plug of silica gel; mixture of diastereomers; (light yellow semisolid, 46 mg, 62% isolated yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.18−4.05 (m, 1H), 4.04−3.94 (m, 2H), 2.03 (dqd, J = 14.8, 7.4, 1.8 Hz, 1H), 1.58−1.42 (m, 1H), 0.97 (s, 9H), 0.91 (d, J = 7.1 Hz, 12H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 79.5, 71.1−70.5 (m), 32.5, 30.6, 27.4, 26.9, 22.8, 19.9, 8.8; IR 2961, 1473, 1135, 827 cm^{-1}; HRMS (ESI) calcd for $C_{13}H_{27}DIO_2Si^+$ 372.0961, found 372.0959 (MH^+).



*2,2-Di-tert-butyl-4-hexyl-5-iodo-1,3,2-dioxasilinane-6-d (**43**).* Synthesized using protocol B; purified using benzene on Florisil; mixture of diastereomers (light yellow semisolid, 57 mg, 67% isolated yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.25−4.15 (m, 1H), 4.11 (ddd, J = 10.2, 7.8, 2.3 Hz, 1H), 4.08−4.00 (m, 1H), 2.13−1.99 (m, 1H), 1.57−1.45 (m, 2H), 1.38−1.19 (m, 7H), 1.04 (s, 9H), 0.99 (s, 9H), 0.92−0.87 (m, 3H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 78.7, 71.3−70.7 (m), 37.7, 33.3, 31.9, 29.0, 27.6, 27.0, 24.6, 23.0, 22.7, 20.0, 14.2; IR 2957, 1473, 1088, 827 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{35}DIO_2Si^+$ 428.1587, found 428.1578 (MH^+).



*2,2-Di-tert-butyl-5-iodo-4-phenyl-1,3,2-dioxasilinane (**44**).* Synthesized using protocol C; purified using 100% benzene on Florisil; single diastereomer (colorless oil, 66 mg, 79%); ^{1}H NMR (400 MHz, chloroform-d) δ 7.48−7.35 (m, 5H), 5.13 (d, J = 9.8 Hz, 1H), 4.48−4.30 (m, 3H), 1.14 (s, 18H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-d) δ 142.4, 128.4, 128.1, 127.3, 82.0, 71.6, 34.2, 27.5, 27.0, 23.0, 20.2; IR 2859, 1471, 903 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{27}IO_2SiNa^+$441.0717, found 441.0669 (MNa^+).



https://doi.org/10.1021/acs.joc.1c00872
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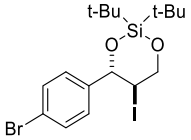
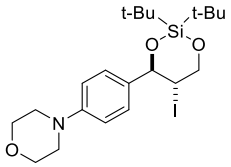
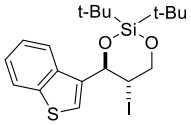
*2,2-Di-tert-butyl-4-(4-fluorophenyl)-5-iodo-1,3,2-dioxasilinane (**45**).* Synthesized using protocol B; purified using 100% benzene on Florisil; single diastereomer (colorless oil, 61 mg, 70%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.46−7.35 (m, 2H), 7.14−7.03 (m, 2H), 5.11 (d, *J* = 10.3 Hz, 1H), 4.47−4.24 (m, 3H), 1.13 (s, 9H), 1.12 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 162.6 (d, *J* = 246.7 Hz), 138.4, 128.9 (d, *J* = 8.1 Hz), 115.0 (d, *J* = 21.3 Hz), 81.2, 71.5, 34.2, 27.5, 27.0, 23.0, 20.1; IR 2859, 1471, 1009 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{27}FIO_2Si^+$ 437.0809, found 437.0796 (MH$^+$).



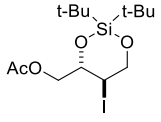
*4-(4-Bromophenyl)-2,2-di-tert-butyl-5-iodo-1,3,2-dioxasilinane (**46**).* Synthesized using protocol B; purified using benzene on Florisil; single diastereomer (colorless oil, 79 mg, 80% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47−7.33 (m, 2H), 7.22−7.12 (m, 2H), 4.94 (d, *J* = 10.3 Hz, 1H), 4.34−4.21 (m, 2H), 4.13 (td, *J* = 10.4, 5.3 Hz, 1H), 0.99 (s, 9H), 0.98 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 141.4, 131.3, 129.0, 122.3, 81.4, 71.5, 33.6, 27.5, 27.0, 23.0, 20.2; IR 2944, 1475, 1110, 827 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{27}BrIO_2Si^+$ 497.0003, found 496.9971 (MH$^+$).



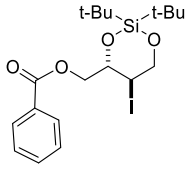
*4-(2,2-di-tert-butyl-5-iodo-1,3,2-dioxasilinan-4-yl)phenyl)-morpholine (**47**).* Synthesized using protocol C; purified using 100% benzene on Florisil; single diastereomer (colorless oil, 50 mg, 50%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.34 (d, *J* = 8.8 Hz, 2H), 6.94 (d, *J* = 8.2 Hz, 2H), 5.10−4.97 (m, 1H), 4.47−4.31 (m, 3H), 3.95−3.85 (m, 4H), 3.22 (dd, *J* = 5.8, 3.9 Hz, 4H), 1.12 (s, 9H), 1.11 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 151.0, 134.0, 128.1, 114.9, 81.5, 71.5, 66.8, 49.0, 34.9, 27.5, 27.0, 23.0, 20.1; IR 2857, 1101, 932 cm^{-1}; HRMS (ESI) calcd for $C_{21}H_{35}INO_3Si^+$ 504.1431, found 504.1426 (MH$^+$).



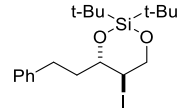
*4-(Benzo[b]thiophene-3-yl)-2,2-di-tert-butyl-5-iodo-1,3,2-dioxasilinane (**48**).* Synthesized using protocol C; purified using 100% benzene on Florisil; single diastereomer (colorless oil, 37 mg, 39%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 8.01 (dd, *J* = 7.5, 1.3 Hz, 1H), 7.95−7.88 (m, 1H), 7.48−7.26 (m, 3H), 5.61 (d, *J* = 10.6 Hz, 1H), 4.70 (dt, *J* = 10.5, 7.9 Hz, 1H), 4.54−4.42 (m, 2H), 1.17 (s, 9H), 1.08 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 140.3, 137.9, 137.8, 124.4, 124.3, 123.9, 122.8, 122.5, 75.5, 71.5, 31.3, 27.5, 27.0, 23.0, 20.0; IR 2833, 1428, 1007 cm^{-1}; HRMS calcd for $C_{19}H_{28}IO_2SSi^+$ 475.0624, found 475.0632 (MH$^+$).



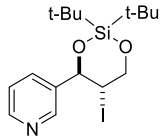
*2,2-Di-tert-butyl-5-iodo-1,3,2-dioxasilinan-4-yl)methyl acetate (**49**).* Synthesized using protocol B; purified using a gradient of 0 to 100% acetone/DCM on Florisil followed by a gradient of 0−100% acetonitrile in 0.1% TFA-H_2O on a RediSep Prep C18 column (100 Å, 5 μm, length 250 mm, i.d.: 20 mm, flow rate of 15 mL/min); single diastereomer (light yellow oil, 60 mg, 72% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.45 (dd, *J* = 11.8, 2.7 Hz, 1H), 4.27 (dd, *J* = 11.4, 3.6 Hz, 1H), 4.21 (dd, *J* = 11.8, 6.0 Hz, 1H), 4.12 (ddd, *J* = 7.6, 5.6, 3.6 Hz, 1H), 4.07−3.98 (m, 2H), 2.05 (s, 3H), 0.98 (s, 9H), 0.97 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 171.4, 71.5, 67.9, 66.2, 34.4, 27.5, 27.4, 20.9, 20.7, 20.5; IR 3442, 2947, 1730, 1246, 829 cm^{-1}; HRMS (ESI) calcd for $C_{14}H_{28}IO_4Si^+$ 415.0796, found 415.0788 (MH$^+$).



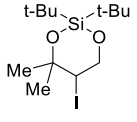
*2,2-Di-tert-butyl-5-iodo-1,3,2-dioxasilinan-4-yl)methyl Benzoate (**50**).* Synthesized using protocol B; purified using a gradient of 0−50% acetone/DCM on Florisil followed by preparative TLC; single diastereomer (light yellow oil, 34 mg, 36% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10−7.99 (m, 2H), 7.62−7.54 (m, 1H), 7.49−7.40 (m, 2H), 4.78 (dd, *J* = 11.9, 2.7 Hz, 1H), 4.54 (dd, *J* = 11.9, 5.8 Hz, 1H), 4.38 (dd, *J* = 11.4, 3.7 Hz, 1H), 4.28 (ddd, *J* = 7.4, 5.7, 3.7 Hz, 1H), 4.19 (ddd, *J* = 7.4, 5.8, 2.7 Hz, 1H), 4.14 (dd, *J* = 11.3, 5.7 Hz, 1H), 1.05 (s, 9H), 1.04 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 167.1, 133.5, 129.9, 129.7, 128.6, 71.8, 68.5, 66.3, 34.8, 27.6, 27.5, 20.8, 20.6; IR 3447, 2933, 1704, 1279, 827 cm^{-1}; HRMS (ESI) calcd for $C_{19}H_{30}IO_4Si^+$477.0953, found 477.0985 (MH$^+$).



*2,2-Di-tert-butyl-5-iodo-4-phenethyl-1,3,2-dioxasilinane (**51**).* Synthesized using protocol B; purified using a gradient of 0−10% EtOAc in hexanes on silica gel; single diastereomer (light yellow solid, 69 mg, 77% isolated yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25−7.19 (m, 2H), 7.17−7.09 (m, 3H), 4.20−4.14 (m, 1H), 4.14−4.06 (m, 1H), 4.03−3.98 (m, 2H), 2.79 (ddd, *J* = 14.1, 9.7, 4.6 Hz, 1H), 2.65 (ddd, *J* = 13.6, 9.4, 7.3 Hz, 1H), 2.37 (dddd, *J* = 13.6, 9.3, 7.3, 1.7 Hz, 1H), 1.81−1.66 (m, 1H), 0.97 (s, 9H), 0.94 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 141.8, 128.6, 128.3, 125.8, 77.7, 71.1, 39.4, 32.7, 31.0, 27.4, 27.0, 22.8, 19.9; IR 2931, 1174, 1042, 825 cm^{-1}; HRMS (ESI) calcd for $C_{19}H_{32}IO_2Si^+$ 447.1211, found 447.1208 (MH$^+$).



*2,2-Di-tert-butyl-5-iodo-1,3,2-dioxasilinan-4-yl)pyridine (**52**).* Synthesized using protocol C; purified using 100% benzene on Florisil; single diastereomer (colorless oil, 42 mg, 50%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 8.61 (d, *J* = 2.3 Hz, 1H), 8.51 (dd, *J* = 4.8, 1.7 Hz, 1H), 7.65 (dt, *J* = 7.8, 1.9 Hz, 1H), 7.30−7.17 (m, 1H), 5.06 (d, *J* = 10.4 Hz, 1H), 4.39−4.26 (m, 2H), 4.19 (td, *J* = 10.3, 5.6 Hz, 1H), 1.02 (s, 9H), 1.02 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 149.7, 149.2, 137.7, 134.5, 123.1, 79.8, 71.4, 33.2, 27.5, 26.9, 23.0, 20.1; IR 2859, 1471, 937 cm^{-1}; HRMS (ESI) calcd for $C_{16}H_{27}INO_2Si^+$ 420.0856, found 420.0845 (MH$^+$).



*2,2-Di-tert-butyl-5-iodo-4,4-dimethyl-1,3,2-dioxasilinane (**53**).* Synthesized using protocol B; purified using a gradient of 0−10% EtOAc in hexanes on silica gel (light yellow semisolid, 59 mg, 80% isolated yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.29 (dd, *J* = 11.8, 3.8 Hz, 1H), 4.24−4.15 (m, 1H), 4.06 (dd, *J* = 11.1, 3.9 Hz, 1H), 1.50 (s, 3H), 1.43 (s, 3H), 0.94 (s, 9H), 0.93 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 75.2, 67.7, 37.1, 31.9, 27.3, 26.3, 21.5, 20.3; IR 2967, 1475, 1165, 825 cm^{-1}; HRMS (ESI) calcd for $C_{13}H_{28}IO_2Si^+$ 371.0898, found 371.0899 (MH$^+$).

https://doi.org/10.1021/acs.joc.1c00872
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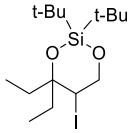
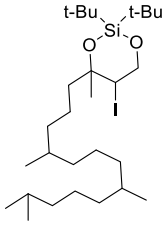
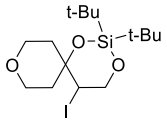


*2,2-Di-tert-butyl-4,4-diethyl-5-iodo-1,3,2-dioxasilinane (**54**).* Synthesized using protocol B; purified using 100% benzene on Florisil (colorless oil, 47 mg, 59%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 4.54 (dd, *J* = 11.8, 4.5 Hz, 1H), 4.35 (t, *J* = 11.5 Hz, 1H), 4.16 (dd, *J* = 11.2, 4.5 Hz, 1H), 2.04 (dt, *J* = 14.7, 7.3 Hz, 1H), 1.89 (dqd, *J* = 14.6, 7.5, 2.4 Hz, 2H), 1.65 (dq, *J* = 14.8, 7.5 Hz, 1H), 1.05 (s, 9H), 1.03 (s, 9H), 1.06–0.98 (m, 6H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 77.8, 67.3, 35.2, 32.4, 28.4, 27.9, 27.3, 21.6, 21.0, 8.2, 8.2; IR 2860, 1475, 1145 cm^{-1}; HRMS (ESI) calcd for $C_{15}H_{32}IO_2Si^+$ 399.1216, found 399.1181 (MH^+).



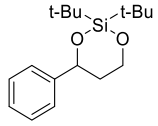
*2,2-Di-tert-butyl-5-iodo-4-methyl-4-(4,8,12-trimethyltridecyl)-1,3,2-dioxasilinane (**55**).* Synthesized using protocol B; purified using benzene on Florisil; mixture of diastereomers (light yellow oil, 81 mg, 70% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.32–4.19 (m, 2H), 4.06 (dd, *J* = 8.9, 1.7 Hz, 1H), 1.84 (tdd, *J* = 13.1, 11.1, 4.6 Hz, 1H), 1.55–0.97 (m, 23H), 0.94 (d, *J* = 4.6 Hz, 18H), 0.79 (dd, *J* = 8.4, 6.6 Hz, 12H); ^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) δ 76.6, 67.6, 44.2, 44.1, 39.4, 37.52, 37.50, 37.48, 37.45, 37.34, 37.28, 37.23, 37.21, 32.84, 32.82, 32.6, 32.5, 28.0, 27.5, 27.4, 24.83, 24.82, 24.48, 24.42, 23.79, 23.77, 22.75, 22.65, 21.4, 20.4, 20.0, 19.9, 19.83, 19.80, 19.77, 19.70; IR 2859, 1377, 1464, 1080, 825 cm^{-1}; HRMS (ESI) calcd for $C_{28}H_{57}INaO_2Si^+$ 603.3065, found 603.3049 (MNa^+).



*2,2-Di-tert-butyl-5-iodo-1,3,9-trioxa-2-silaspiro[5.5]undecane (**56**).* Synthesized using protocol B; purified using 100% benzene on Florisil (colorless oil, 36 mg, 44%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 4.35–4.16 (m, 2H), 4.06 (dd, *J* = 11.0, 3.4 Hz, 1H), 3.83–3.67 (m, 4H), 2.36–2.17 (m, 2H), 1.67 (dt, *J* = 13.6, 2.4 Hz, 1H), 1.34 (dt, *J* = 13.4, 2.3 Hz, 1H), 0.95 (s, 9H), 0.96 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 73.4, 66.6, 63.8, 63.0, 38.5, 37.5, 33.5, 27.5, 27.2, 21.5, 20.3; IR 2861, 1471, 924 cm^{-1}; HRMS (ESI) calcd for $C_{15}H_{29}IO_3SiNa^+$ 435.0828, found 435.0851 (MNa^+).

V. Scale-up Procedure. A round-bottom flask was charged with stir bar, alkene substrate (870 mg, 2.97 mmol, 1 equiv), AgOTf (841 mg, 3.3 mmol, 1.3 equiv), and 25 mL of anhydrous DME. The reaction vial was immersed in a bath set to −15 °C. I_2 (830 mg, 3.2 mmol, 1.2 equiv) was added in one portion. A light-yellow precipitate formed immediately upon addition of AgOTf. The heterogeneous mixture was stirred for 2 h at −15 °C and then quenched by addition of aqueous saturated $Na_2S_2O_3$. The reaction mixture was diluted with ethyl acetate and transferred to a separatory funnel. The organic portion was collected, and the aqueous layer was extracted with two additional portions of ethyl acetate. The organic fractions were pooled, dried with $MgSO_4$, and concentrated under reduced pressure. The resulting residue was purified by chromatography on Florisil (100% benzene) to yield a light yellow solid (1.14 g, 2.72 mmol, 92% yield).

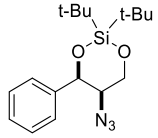
VI. Procedures for Derivatization Reactions. **44** (70 mg, 0.16 mmol) was dissolved in 6 mL of DCM. Tributyltin hydride (97 μL, 0.36 mmol) was added, and the reaction was stirred for 12 h at 40 °C (oil bath). The reaction mixture was concentrated, and the resulting residue was purified by chromatography on silica gel to yield **57** as a colorless oil (41 mg, 83%).



57

*Compound **57**.* Purified using a gradient of 0–10% EtOAc in hexanes on silica gel (colorless oil, 83%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.48–7.35 (m, 4H), 7.35–7.26 (m, 1H), 5.22 (dd, *J* = 11.3, 2.3 Hz, 1H), 4.33 (ddd, *J* = 12.5, 11.1, 2.4 Hz, 1H), 4.21 (ddd, *J* = 11.0, 4.5, 2.0 Hz, 1H), 2.09 (dddd, *J* = 14.4, 12.5, 11.3, 4.5 Hz, 1H), 1.89 (dq, *J* = 14.4, 2.3 Hz, 1H), 1.15 (s, 9H), 1.13 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 144.9, 128.3, 127.0, 125.0, 75.9, 64.7, 39.5, 27.5, 27.2, 22.9, 20.1; IR 2859, 1473, 886 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{29}O_2Si^+$ 293.1937, found 293.1938 (MH^+).

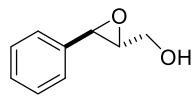
Compound **44** (70 mg, 0.16 mmol) was dissolved in 0.5 mL of DMF. To this solution were added sodium azide (0.32 mmol, 2 equiv) and 15-crown-5 (0.32 mmol, 2 equiv) at room temperature. The temperature of the reaction was gradually increased to 100 °C (oil bath) and kept at this temperature for 12 h with magnetic stirring. After consumption of starting material (followed by TLC), the reaction mixture was diluted with EtOAc and transferred to a separatory funnel. The organic layer was washed with cold water (3 × 3 mL). The organic layer was collected, dried over Na_2SO_4, and concentrated under reduced pressure. The resulting residue was purified by chromatography on silica gel to yield compound **58** (24 mg, 43%) as a colorless solid.



58

*Compound **58**.* Purified using benzene on Florisil; single diastereomer (colorless solid, 54%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.46–7.35 (m, 5H), 5.46 (d, *J* = 2.0 Hz, 1H), 4.56 (dd, *J* = 12.5, 1.8 Hz, 1H), 4.39 (dd, *J* = 12.5, 2.0 Hz, 1H), 3.82 (q, *J* = 1.9 Hz, 1H), 1.20 (s, 9H), 1.14 (s, 9H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 140.6, 128.2, 127.7, 125.7, 76.3, 66.1, 64.4, 27.7, 27.2, 23.5, 20.7; IR 2860, 1474, 889 cm^{-1}; HRMS (ESI) calcd for $C_{17}H_{28}N_3O_2Si^+$ 334.1951, found 334.1960 (MH^+).

TBAF in THF (1 M, 0.280 mL, 0.28 mmol) was added to compound **44** (40 mg, 0.09 mmol) in THF (2 mL) at 0 °C, and the reaction was warmed to room temperature over 16 h. Following this time, the reaction mixture was concentrated, and the resulting residue was purified by chromatography on silica gel to yield **59** (9 mg, 63%) as a colorless oil.



59

*Compound **59**.* Purified using a gradient of 0 to 20% EtOAc in hexanes on silica gel; single diastereomer (colorless oil, 63%); ^{1}H NMR (600 MHz, chloroform-*d*) δ 7.44–7.25 (m, 5H), 4.09 (dd, *J* = 12.8, 2.4 Hz, 1H), 3.97 (d, *J* = 2.1 Hz, 1H), 3.84 (dd, *J* = 12.8, 3.8 Hz, 1H), 3.27 (dt, *J* = 4.2, 2.4 Hz, 1H), 1.95 (s, 1H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 136.6, 128.5, 128.3, 125.7, 62.3, 61.1, 55.5.

HF·pyridine (~70% HF–30% pyridine, 75 μL) was added to compound **44** (40 mg, 0.09 mmol) in THF at 0 °C, and the mixture was stirred for 5 min. The reaction was quenched with saturated aqueous $NaHCO_3$ and transferred to a separatory funnel. The water layer was extracted with three portions of ethyl acetate. The organic layers were collected, pooled, and dried with Na_2SO_4. After concentration under reduced pressure, the resulting residue was

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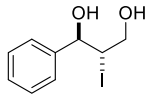
purified by chromatography on silica gel to yield **60** (13 mg, 49%) as a colorless oil.



60

Compound ***60***. Purified using a gradient of 0−40% EtOAc in hexanes on silica gel (colorless oil, 49%); ^{1}H NMR (400 MHz, chloroform-*d*) δ 7.47−7.32 (m, 5H), 5.08 (dd, J = 6.3, 2.5 Hz, 1H), 4.53−4.42 (m, 1H), 4.00 (dd, J = 12.3, 4.6 Hz, 1H), 3.91−3.78 (m, 1H), 2.75−2.5 (bs, 2H); ^{13}C{^{1}H} NMR (101 MHz, chloroform-*d*) δ 140.8, 128.6, 128.5, 126.5, 78.5, 65.9, 41.3; IR 2926, 1455, 1002 cm^{-1}; HRMS (ESI) calcd for $C_9H_{11}IO_2Na^+$ 300.9702, found 300.9744 (MNa^+).

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acs.joc.1c00872.

Expanded procedures, crystal structure data, NMR spectra and computational details (PDF)

Accession Codes

CCDC 2062814 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif, or by emailing data_request@ccdc.cam.ac.uk, or by contacting The Cambridge Crystallographic Data Centre, 12 Union Road, Cambridge CB2 1EZ, UK; fax: +44 1223 336033.

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Notes

The authors declare no competing financial interest.

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