

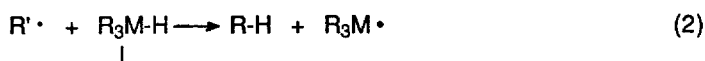
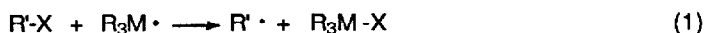
## TRIS(TRIMETHYLSILYL)SILANE: A CATALYST FOR RADICAL MEDIATED REDUCTION REACTIONS<sup>1</sup>

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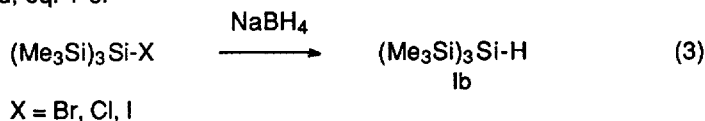
**Summary:** Tris(trimethylsilyl)silane was an effective substitute for toxic, tributyltin hydride in free radical chain reductions of organic halides. It was used in catalytic amounts and was regenerated, *in situ*, by using sodium borohydride.

Methods of chemical synthesis that involve free radicals have been growing in importance over the last decade<sup>3-6</sup> and many of these have employed tributyltin hydride, 1a, as a reducing agent,<sup>7</sup> reactions 1 and 2. Indeed, in his recent review of these methods,<sup>5,6</sup> Curran dedicated almost half of the several hundred citations to tin hydride based chemistry.



Despite its extensive use, tributyltin hydride (1a) has several disadvantages. It is difficult to remove the tin-containing byproducts from the reaction mixtures. Moreover, the tin hydride is toxic and is therefore unacceptable for pharmaceutical applications.

We have recently shown<sup>8-9</sup> that tris(trimethylsilyl)silane, 1b, can be used in place of tributyltin hydride as a radical-based reducing agent. However, like tin hydride it has a relatively high, molecular weight and only delivers one reducing equivalent of hydrogen. In an attempt to overcome this deficiency, we used sodium borohydride to regenerate the silane, *in situ*, from its silyl halide, eq. 3.<sup>10-14</sup> The silane can then be used in catalytic amounts and sodium borohydride becomes the reductant that is consumed, eq. 1-3.



In a typical experiment, the alkyl halide (0.1 M) was dissolved in monoglyme<sup>15</sup> (3 mL) in a quartz tube equipped with a magnetic stirrer. Sodium borohydride (5 M) was added and the mixture was purged with argon. After 2 hours, GC analysis showed that little or no reduction had been effected by the sodium borohydride. Tris(trimethylsilyl)silane (0.01M) together with *p*-methoxybenzoyl peroxide<sup>16</sup> ( $2 \times 10^{-3}$  M) were then added and the mixture was photolyzed at 254 nm in a Rayonet reactor. Under these conditions smooth reduction was achieved. The peroxide functioned as a photoinitiator that has an excellent absorption at the photolysis wavelength and the

*p*-methoxy groups ensured that it was quite resistant to reduction by the borohydride. Photolysis in the absence of the initiator caused the reaction to proceed at a very low rate.

A variety of halides were tested and the yields for their reductions are reported in Table 1. For comparison, yields are also reported for reactions carried out without sodium borohydride and with an equimolar amount of tris(trimethylsilyl)silane. The results show that the borohydride works well in most cases and will even support the reduction of cholesteryl iodide where the intermediate radical is allylic and should not be an efficient chain carrier.

**Table 1. Yields for the Reductions of Organic Halides, R-X using Catalytic Quantities of Tris(trimethylsilyl)silane together with Sodium Borohydride**

R-X	Yield R-H (%) <sup>a</sup>	Yield R-H (%) <sup>b</sup>
C <sub>18</sub> H <sub>37</sub> I	68	78
C <sub>16</sub> H <sub>33</sub> Br	85	86
1-Bromonaphthalene	88	91
1-Bromoadamantane	90	99
Cholesteryl iodide	55 <sup>c</sup>	75

<sup>a</sup>By GC analysis; using sodium borohydride and tris(trimethylsilyl)silane. <sup>b</sup>Using an equimolar quantity of tris(trimethylsilyl)silane. <sup>c</sup>Isolated yield 45%.

The usefulness in driving reactions through a radical mechanism has been demonstrated many times.<sup>3-6</sup> The present results clearly show that tris(trimethylsilyl)silane can be used as a catalyst for this purpose with sodium borohydride as the consumable.

#### References and Notes

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- 15) For the analogous tin halide reductions, ethanol appears to be the solvent of choice. However, it cannot be used in this case since it reacts directly with the silyl halides.
- 16) We thank Dr. J. Luszyk for a gift of this material.

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