or mixtures of allene and acetylene, our studies indicate that the corresponding coupling of metal acetylide with an *allenic* bromide or iodide under the proper conditions can lead to 1,4-diynes in high yield. This process, which will be discussed in more general terms in a separate paper, has been applied to the synthesis of 11(*R*)-HETE (**2**) as follows. The acetylenic diene **6** in THF at -45 °C was converted to the lithio derivative (1 equiv of *n*-butyllithium) and thence to a mixed Gilman reagent with 1.1 equiv of cuprous cyanide in THF-HMPA at -20 °C. After 10 min, methyl 5-bromo-5,6-heptadienoate (**7**)[10] in THF was added and the mixture (final ratio of HMPA to THF 1.1:1) was stirred at 4 °C for 12 h and 23 °C for 48 h. Extractive isolation and chromatography on silica gel gave pure coupled diyne **8** in 89% yield.[11] Conversion of **8** to the methyl ester of **2** was cleanly effected by selective hydrogenation (Lindlar catalyst in hexane-triethylamine, 1 atm of H_2) to the corresponding *cis,cis,trans,-cis*-tetraene and desilylation[12] using tetra-*n*-butylammonium fluoride in THF at 25 °C; the methyl ester of **2** showed $[\alpha]^{25}{}_D$ +10.97° (*c* 1.0, CH_2Cl_2); UV_{max} (hexane) 235 nm; ^1H NMR spectrum ($CDCl_3$, 80 MHz) δ 6.54 (dd, J = 10.8, 15.0 Hz, 1 H), 5.96 (br t, J = 10.8 Hz, 1 H), 5.1-5.8 (m, 6 H), 4.22 (q, J = 7.0 Hz, 1 H), 3.66 (s, 3 H), 2.79 (t, J = 5.1 Hz, 2 H), 2.32 (t, J = 7.0 Hz, 2 H) 1.1-2.2 (m, 14 H), 0.88 (t, J = 6 Hz, 3 H). This ester is best stored in frozen benzene under argon in the presence of a trace of 4-hydroxy-2,2,6,6-tetramethylpiperidinoxy free radical at <-20 °C.[13] 11(*R*)-HETE is readily obtained from the ester by saponification at 25 °C in the absence of air, acidification, and extractive isolation;[3] it is relatively unstable to storage compared to the methyl ester.

Further studies on **1** and **2** and the biomimetic synthesis of prostaglandins are underway and will be reported in due course.[14]

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(10) Methyl 5-bromo-5,6-heptadienoate (**7**) was synthesized in 76% yield by reaction of methyl 7-(trimethylsilyl)-5-heptynoate with 1 equiv of bromine in methylene chloride at -78 °C.

(11) An obvious route to **8** involving the ethynylation of the epoxide corresponding to diol derivative **4** using the lithio acetylide from 5,8-nonadiynoate ion (or ester) was foiled by the acidity of the 1,4-diyne unit and consequent instability of the ethynylating reagent.

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^{13}C Magic Angle NMR Study of the Isomerization of *cis*- to *trans*-Polyacetylene

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Polyacetylene occupies a central position in the burgeoning field of conducting polymers.[1] In spite of the discovery of several other polymers dopable to high conductivity,[2-7] polyacetylene continues to be the prototypical model, and efforts to understand its electrical properties are viewed as necessary for rational design of new systems. Such understanding requires a knowledge of the microstructure; unfortunately the insolubility of polyacetylene has made the acquisition of this knowledge difficult.

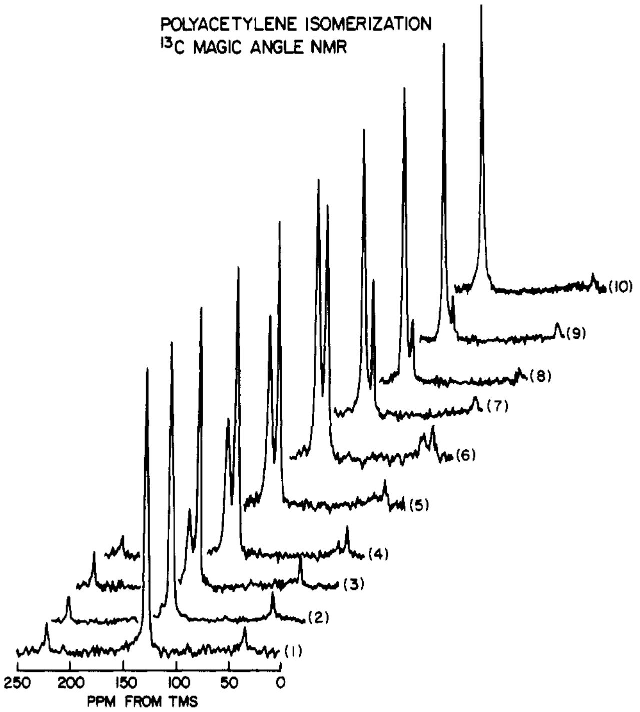
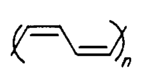


Figure 1. 22.63-MHz carbon-13 NMR spectra of a 12 mg initially high cis content polyacetylene as isomerization progresses to the trans form. Proton enhanced cross-polarization conditions: repetition time = 1 s; contact time = 1 ms, with resonant radio frequency field of 8 and 32 G for protons and carbons, respectively; proton decoupling power = 12 G; no. of scans ~50000 per spectrum; spinning speed = 2.2-2.5 KHz. Spectra are arbitrarily normalized to the larger of the two peaks. Percent trans determined from IR absorption ratio (740 vs. 1010 cm^{-1})[8] and the corresponding thermal history for each spectrum: (1) 32% (25 °C, 1.5 days); (2) 47% (25 °C, 9 days); (3) 47% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 1 h); (4) 52% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 2 h); (5) 51% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 4 h); (6) 48% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 7.5 h); (7) 59% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 22.8 h); (8) 54% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 47 h); (9) 85% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 64 h); (10) 94% (25 °C, 11 days; 78 °C, 1 h; 100 °C, 64 h; 200 °C, 21 min).

The isomerization of the as-formed cis-transoid isomer (**1**) to the trans-transoid isomer (**3**) has been studied by IR[8,9] and ESR spectroscopy.[10] The individual isomers have also been examined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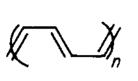
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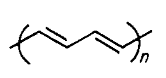
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by ^{13}C magic angle NMR spectroscopy.[11] We now report a study of the isomerization process by a combination of IR and NMR spectroscopy and a discrepancy in composition as measured by the two techniques.

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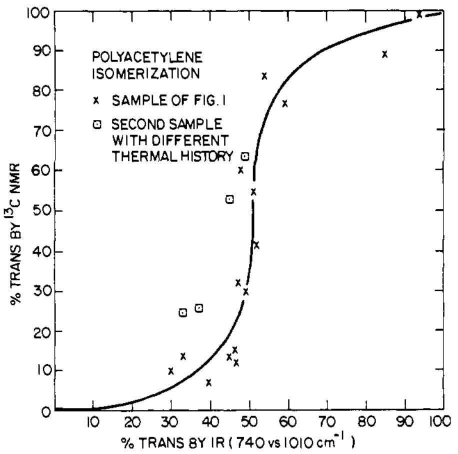

Figure 2. Percent polyacetylene trans isomer as calculated from integrated peak areas in the NMR spectra vs. trans content determined from absorbances of the 1010- (trans) and 740-cm^{-1} (cis) bands in the IR spectra.[8]

Polyacetylene was prepared by the Shirakawa technique[12] and stored at −80 °C. Samples for IR and NMR spectroscopy were handled in an oxygen-free (<0.8 ppm) glove box under argon. Cis/trans content was determined by using the 740- ("*cis*") and 1010-cm^{-1} ("trans") IR bands.[8] A sample initially 30% trans by IR analysis was monitored at 25 °C for 11 days as it became 47% trans by IR analysis. The sample was then treated incrementally at 100 °C until was 85% trans by IR spectroscopy and then at 200 °C to yield 94% trans by IR analysis.

The NMR spectra for this series of isomerization experiments are shown in Figure 1. The cis peak appears at 128.5 ± 0.4 ppm and the trans at 137.3 ± 0.4 ppm downfield from Me_4Si. Note that the trans signal is nearly absent from the initial 30% trans (IR) sample. Even after 9 days at 25 °C the 47% trans (IR) sample shows only a weak trans NMR signal. But upon isomerization at higher temperature (100 °C), the trans NMR peak does appear, weak at first but increasing in intensity, in spite of the fact that IR analysis reveals no meaningful change in composition. This is graphically illustrated in Figure 2; in the range where NMR indicates a change from 15% to 85% trans, IR shows very little change (45% to 55% *trans*).

The discrepancy in cis/trans ratios determined by NMR peak integration and conventional IR analysis can be rationalized by considering (i) the IR analysis to be in error because of sequence length effects upon the apparent relative extinction coefficients of the cis (**1**) and trans (**3**) peaks,[13] (ii) the downfield NMR peak, assigned to the trans isomer, to be due solely to triad or longer trans sequences, (iii) the existence of a third isomer, the trans-cisoid (**2**),[14] those NMR chemical shift is nearly the same as that of the cis peak, or (iv) the polymer crystalline and amorphous regions to have different isomerization rates[15] and nonquantitative relative ^{13}C peak intensities.[16] More detailed work is in progress to differentiate these possibilities.

It is noteworthy that the thermal history of the polyacetylene affects the relationship between the IR and NMR results as shown in Figure 2 for a second independent sample. This suggests that one or more of the aforementioned structural features is/are dependent upon thermal history. Thus, carefully monitored sample histories are crucial to detailed understanding of the microstructure of polyacetylene and, by inference, its physical and chemical properties.

These findings clearly demonstrate the inadequacy of IR determination of composition and the importance of sample history. While these results underscore the complexity of polyacetylene, they provide the basis for understanding a number of conflicting electrical, magnetic, and spectroscopic measurements reported for this interesting polymer.

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[14] The calculated total energies of isomers **1** and **2** are very similar: 1.9 and 2.1 kcal per C_2H_2 unit, respectively, relative to **3** (Karpfen, A.; Holler, R. *Solid State Commun.* **1980**, *37*, 179. This argument would require that in the IR spectra both **2** and **3** appear at ca. 1010 cm^{-1}, in contrast to the normal mode analysis of Shirakawa and Ikeda (Shirakawa, H.; Ikeda, S. *Polym. J.* **1971**, *2*, 231).

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cis-Diamminedichloroplatinum(II) Binds in a Unique Manner to Oligo(dG)·Oligo(dC) Sequences in DNA—A New Assay Using Exonuclease III

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Previous experiments[1] suggested that the antitumor drug *cis*-diamminedichloroplatinum(II) (*cis*-DDP) binds in a sequence specific manner to DNA. In particular, low levels of bound *cis*-DDP selectively inhibit the restriction endonuclease Pst I from cutting plasmid pSM1 at a site with an adjacent $(dG)_4\cdot(dC)_4$ sequence. This sequence was noteworthy since binding of *cis*-DDP to poly(dG)·poly(dC) produces substantially greater buoyant density increases than binding to poly(dG·dC).[2] Here we demonstrate more directly that *cis*-DDP binds in a unique fashion to $(dG)_n\cdot(dC)_n$, $n \geq 2$, sequences in DNA through a new assay by using exonuclease III in conjunction with DNA sequencing techniques.

Both the Maxam–Gilbert[3] and Sanger[4] methods of rapid DNA sequencing employ a strategy whereby the position and type of base in the sequence of a DNA molecule are determined by the distance of that base from one end of the chain. This determination is achieved by constructing a set of fragments of the DNA molecule whose sequence is desired. These fragments have two important characteristics. The first is that they all have one end in common. This requirement is assured in the Maxam–Gilbert method by radioactively labeling one end of one strand of the DNA duplex. The second characteristic of the fragments is that their other ends occur only at the positions of one of the four nucleotide bases. The Maxam–Gilbert technique accomplishes this objective by means of four chemically different sets of reactions, each of which specifically breaks the phosphodiester backbone of the DNA molecule at one type of base.

For a visualization of the sequence, the products of these four base-specific reactions are run in parallel on a high-resolution electrophoresis gel which is capable of separating DNA molecules differing in length by only one base. Autoradiography of the gel reveals the positions of the radioactively labeled fragments. The distance of migration of each molecule is proportional to its length. From the chemical reaction used to cleave the DNA chain to produce a fragment of a specific length, one may identify the base occurring at that position in the sequence. We have employed

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