

## Chelating and Telluroate Ligand-Transfer Studies of the Complex $fac-[Fe(CO)_3(TePh)_3]^-$ : Crystal Structures of Heterodinuclear $(CO)_3Mn(\mu-TePh)_3Fe(CO)_3$ and $CpNi(TePh)(PPh_3)$

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Complex  $fac-[Fe(CO)_3(TePh)_3]^-$  was employed as a "metallo chelating" ligand to synthesize the neutral  $(CO)_3Mn(\mu-TePh)_3Fe(CO)_3$  obtained in a one-step synthesis by treating  $fac-[Fe(CO)_3(TePh)_3]^-$  with  $fac-[Mn(CO)_3(CH_3CN)_3]^+$ . It seems reasonable to conclude that the  $d^6$  Fe(II)  $[(CO)_3Fe(TePh)_3]^-$  fragment is isolobal with the  $d^6$  Mn(I)  $[(CO)_3Mn(TePh)_3]^{2-}$  fragment in complex  $(CO)_3Mn(\mu-TePh)_3Fe(CO)_3$ . Addition of  $fac-[Fe(CO)_3(TePh)_3]^-$  to the  $CpNi(I)(PPh_3)$  in THF resulted in formation of the neutral  $CpNi(TePh)(PPh_3)$  also obtained from reaction of  $CpNi(I)(PPh_3)$  and  $[Na][TePh]$  in MeOH. This investigation shows that  $fac-[Fe(CO)_3(TePh)_3]^-$  serves as a tridentate metallo ligand and telluroate ligand-transfer reagent. The study also indicated that the  $fac-[Fe(CO)_3(SePh)_3]^-$  may serve as a better tridentate metallo ligand and chalcogenolate ligand-transfer reagent than  $fac-[Fe(CO)_3(TePh)_3]^-$  in the syntheses of heterometallic chalcogenolate complexes.

### INTRODUCTION

The investigation of metal-telluroate chemistry has been actively pursued recently,<sup>1</sup> motivated primarily by the bonding diversity, reactivity, and the potential use as precursors for metal-telluride materials.<sup>2</sup>

Recent work in this laboratory has shown that  $fac-[Fe(CO)_3(SePh)_3]^-$  can serve as a chelating and selenolate ligand-transfer reagent to synthesize (1) distorted square planar  $[Ni(CO)(SePh)_3]^-$ , the potential biomimetic nickel-site structure of CO dehydrogenases, from reaction of  $fac-[Fe(CO)_3(SePh)_3]^-$ ,  $[CpNi(CO)]_2$ , and  $(SePh)_2$  via chelating and selenolate ligand-transfer,<sup>3</sup> (2) heterotrimetallic Fe(II)-M-Fe(II)-selenolate complexes  $(CO)_3Fe(\mu-SePh)_3M(\mu-SePh)_3Fe(CO)_3$  (M = Fe, Ni, Zn, Cd) with a unique homoleptic hexaselenolatometal ( $MSe_6$ ) core, respectively,<sup>4</sup> and  $[(CO)_3Mn(\mu-S-2-S-C_4H_5S)_3Ni(\mu-SePh)_3Fe(CO)_3]^-$  with heteroleptic hexachalcogenolatonickel ( $NiS_3Se_3$ ) core;<sup>5</sup> and (3) neutral  $[Fe(CO)_2(phen)(SePh)_2]$  (phen = 1, 10-phenanthroline) requiring intermetal selenolate and CO ligands-transfer from  $fac-[Fe(CO)_3(SePh)_3]^-$  to  $[Fe(phen)_3]^{2+}$  (redistribution reaction).<sup>4</sup>

Here we examined the reactivity of the analogue, iron(II)-telluroate species  $fac-[Fe(CO)_3(TePh)_3]^-$ ,<sup>6</sup> by react-

ing it with  $fac-[Mn(CO)_3(CH_3CN)_3]^+$  and  $CpNi(I)(PPh_3)$  individually. Specifically, synthesis and characterization of the heterodinuclear  $Fe^{II}-Mn^I$ -telluroate and the neutral  $Ni^{II}$ -telluroate complex by employing  $fac-[Fe(CO)_3(TePh)_3]^-$  as a chelating and intermetal telluroate ligand-transfer reagent are described.

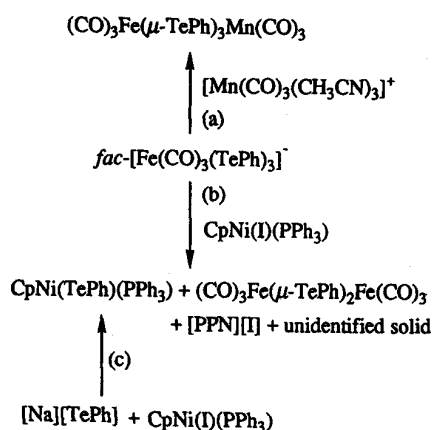
### RESULTS AND DISCUSSION

As illustrated in Scheme Ia, when a THF solution of  $fac-[Fe(CO)_3(TePh)_3]^-$  and  $[Mn(CO)_3(CH_3CN)_3][PF_6]$  are stirred under  $N_2$ ,<sup>7</sup> a reaction ensues over the course of 12 h at ambient temperature to yield the neutral heterodinuclear  $(CO)_3Mn(\mu-TePh)_3Fe(CO)_3$  (**1**) in 80% isolated yield after removal of  $[PPN][PF_6]$  by diethyl-ether/hexane and recrystallization with hexane-diethyl ether. The brown purple, heterodimetallic complex **1** which is soluble in common organic solvents like THF and  $CH_2Cl_2$ , displays no tendency to decompose under nitrogen at room temperature. The carbonyl stretching bands 2063 s, 2003 vs of complex **1** (compared to  $\nu(CO)$  2021 s, 1963 s of  $fac-[Fe(CO)_3(TePh)_3]^-$ )<sup>6</sup> were assigned to the  $Fe^{II}(CO)_3$  fragment, and the stretching bands 1923 s, 2003 vs (compared to  $\nu(CO)$  1896 s, 1970 s of



$[(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Mn}(\text{CO})_3]^-$ <sup>8</sup> were attributed to the CO stretching bands of the  $\text{Mn}^{\text{I}}(\text{CO})_3$  fragment of complex **1**. The IR  $\nu(\text{CO})$  data suggested its formulation of  $(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Fe}(\text{CO})_3$  with the two metal ions,  $\text{Mn}^{\text{I}}$  and  $\text{Fe}^{\text{II}}$ , being bridged by three phenyltellurolates, which was also confirmed by X-ray crystallography.  $^1\text{H}$  NMR spectra are consistent with the presence of the low-spin octahedrally coordinated  $d^6$  Fe(II) and  $d^6$  Mn(I) ions with facial carbonyls. In light of this result, the neutral  $(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Fe}(\text{CO})_3$  feature octahedral coordination about each of the Mn(I) and Fe(II) ions with three terminal carbonyls in the facial positions and bears a closer structural resemblance to the reported  $[(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Mn}(\text{CO})_3]^-$ ,<sup>8</sup> i.e. the  $d^6$  Fe(II)  $[\text{Fe}(\text{CO})_3]^{2+}$  fragment is isolobal with the  $d^6$  Mn(I)  $[\text{Mn}(\text{CO})_3]^+$  fragment.<sup>9</sup>

### Scheme I



The neutral complex **1** appears to have no precedent in heterodinuclear-tellurolate chemistry.

In contrast, reactions of  $\text{fac-}[\text{Fe}(\text{CO})_3(\text{TePh})_3]^-$  with  $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ ,  $\text{Zn}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$ ,  $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ,  $\text{Fe}(\text{ClO}_4)_2 \cdot \text{H}_2\text{O}$  were not successful in synthesizing heterotrimetallic tellurolates  $(\text{CO})_3\text{Fe}(\mu\text{-TePh})_3\text{M}(\mu\text{-TePh})_3\text{Fe}(\text{CO})_3$  ( $\text{M} = \text{Cd}$ ,  $\text{Zn}$ ,  $\text{Ni}$ ,  $\text{Fe}$ ) with a homoleptic hexatellurolatometal core  $\text{M}(\text{Te})_6$ , respectively. This is in contrast to the observation that heterotrimetallic selenolate complexes  $(\text{CO})_3\text{Fe}(\mu\text{-SePh})_3\text{M}(\mu\text{-SePh})_3\text{Fe}(\text{CO})_3$  were readily obtained under similar reaction conditions.<sup>4</sup>

In comparison, the addition of one equiv of  $\text{fac-}[\text{Fe}(\text{CO})_3(\text{TePh})_3]^-$  to a THF solution of  $\text{CpNi(I)(PPh}_3\text{)}$  under  $\text{N}_2$  led to the isolation of dark red-brown  $\text{CpNi(TePh)(PPh}_3\text{)}$ , the known  $(\text{CO})_3\text{Fe}(\mu\text{-TePh})_2\text{Fe}(\text{CO})_3$ ,<sup>10</sup>  $[\text{PPN}][\text{I}]$ , and the unidentified solid (Scheme Ib). The complex  $\text{CpNi(TePh)(PPh}_3\text{)}$  (**2**) is soluble and stable in THF, and crystallized from THF-hexane at  $-15^\circ\text{C}$ . The most likely explanation for the formation of complex **2** is that  $\text{fac-}[\text{Fe}(\text{CO})_3(\text{TePh})_3]^-$  was employed as an

intermetal tellurolate ligand-transfer reagent. The  $^1\text{H}$  and  $^{13}\text{C}$  NMR spectrum of complex **2** shows the expected signals ( $^1\text{H}$  NMR ( $\text{C}_4\text{D}_8\text{O}$ ):  $\delta$  4.99 (s) ppm (Cp);  $^{13}\text{C}$  NMR ( $\text{C}_4\text{D}_8\text{O}$ ):  $\delta$  93.96 (s) ppm (Cp)) for the Cp ring involved and displayed characteristics of diamagnetic  $d^8$   $\text{Ni}^{\text{II}}$  species. Additionally, when  $\text{CpNi(I)(PPh}_3\text{)}$  was reacted in stoichiometric proportions with  $[\text{Na}][\text{TePh}]$  (obtained from reaction of  $[\text{Na}][\text{BH}_4]$  and  $(\text{TePh})_2$  in 2:1 ratio) in MeOH under  $\text{N}_2$ , the neutral red brown complex **2** was also obtained after being separated from NaI (Scheme Ic).

The X-ray structural analysis of complex **1** is depicted in Fig. 1; selected bond distances and angles are collected in Table 2. In a first approximation, the  $\text{MnTe}_3(\text{CO})_3/\text{FeTe}_3(\text{CO})_3$  fragments may be described as face-sharing octahedra. The phenyl groups of three bridging benzenetellurolates in **1** form a regular propeller-like arrangement around the  $\text{Te}_3$  plane defined by the three telluriums. In a sense, neutral complex **1** is isostructural with the anion  $[(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Mn}(\text{CO})_3]^-$ . Complex **1** contains discrete dinuclear units in which the  $d^6$  Mn(I) and  $d^6$  Fe(II) ions are unsymmetrically bridged by three benzenetellurolates. The average Fe-TePh bond length of 2.631(1) Å in **1** is comparable with the reported terminal Fe-TePh bond length of 2.630(4) Å in  $\text{fac-}[\text{Fe}(\text{CO})_3(\text{TePh})_3]^-$ .<sup>6</sup> The bridging Mn-TePh distances (average 2.654(1) Å) in complex **1** are comparable to those in  $[(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Mn}(\text{CO})_3]^-$  (average 2.666(2) Å),<sup>8</sup> in  $\text{cis-}[\text{Mn}(\text{CO})_4(\text{TePh})_2]^-$  (average 2.673(1) Å).<sup>8</sup> The distinctly differential Fe-TePh (2.631(1) Å) and Mn-TePh (2.654(1) Å) bond distances (Fe-TePh distance is ca. 0.02 Å shorter than the Mn-TePh distance) also support the formation of complex **1** as a heterodinuclear  $\text{Fe}^{\text{II}}\text{-Mn}^{\text{I}}$ -tellurolate complex consistent with the conclusion in IR  $\nu(\text{CO})$  data. The larger Te-Fe-Te angle (average  $82.08(3)^\circ$ ) compared with the Te-Mn-Te angles (average

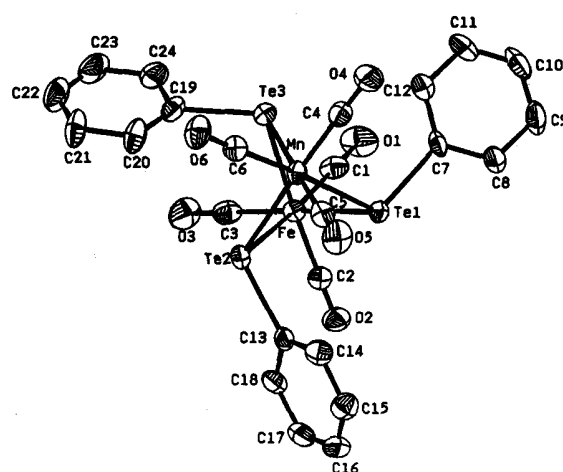


Fig. 1. ORTEP drawing and labeling scheme of the neutral  $(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Fe}(\text{CO})_3$  with thermal ellipsoids drawn at the 30% probability level.

Table 1. Crystallographic Data of Complexes **1**, and **2**

	<b>1</b>	<b>2</b>
chem formula	C <sub>24</sub> H <sub>15</sub> O <sub>6</sub> MnFeTe <sub>3</sub>	C <sub>29</sub> H <sub>25</sub> PTeNi
fw	892.95	590.79
cryst syst	monoclinic	triclinic
space group	P 2 <sub>1</sub> /n	P 1̄
λ, Å (Mo Kα)	0.7107	0.7107
a, Å	8.961(1)	9.744(2)
b, Å	17.496(3)	11.466(3)
c, Å	17.309(2)	11.805(1)
α, deg		80.07(2)
β, deg	97.86(1)	73.66(1)
γ, deg		82.64(2)
V, Å <sup>3</sup>	2688.2(7)	1242.3(4)
Z	4	2
d <sub>calcd</sub> , g cm <sup>-3</sup>	2.206	1.579
F(000)	1650	578
μ, cm <sup>-1</sup>	42.283	20.156
T, °C	23	23
R <sup>a</sup>	0.032	0.027
R <sub>w</sub> <sup>b</sup>	0.028	0.027
GOF <sup>c</sup>	1.23	2.42

<sup>a</sup>  $R = \sum|(F_o - F_c)| / \sum F_o$ . <sup>b</sup>  $R_w = [\sum \omega(F_o - F_c)^2 / \sum \omega F_o^2]^{1/2}$ .

<sup>c</sup>  $GOF = [\sum[\omega(F_o - F_c)^2 / (M - N)]^{1/2}$  where M = number of reflections and N = number of parameters.

81.20(3)°, observed in complex **1**, is ascribed to the proximity of the bridging benzenetelluroate groups to the Fe(II) center.

The crystal structure of the neutral CpNi(TePh)(PPh<sub>3</sub>) was determined with X-ray diffraction (Fig. 2). The terminal Ni<sup>II</sup>-TePh bond length of 2.4804(6) Å observed in complex **2** is comparable to Ni-Te distance in CpNi(Te-C<sub>6</sub>H<sub>3</sub>Me<sub>3</sub>)-

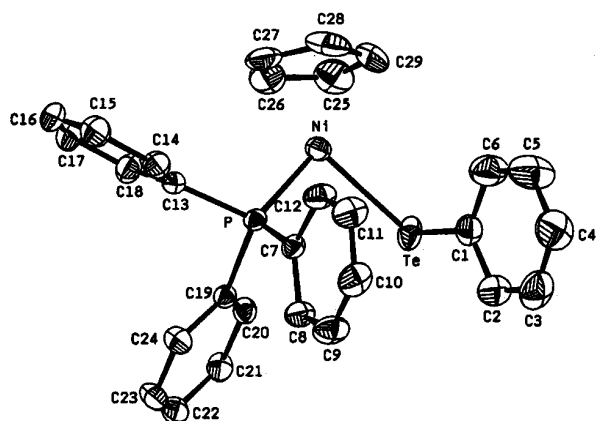


Fig. 2. ORTEP drawing and labeling scheme of the CpNi(TePh)(PPh<sub>3</sub>) with thermal ellipsoids drawn at the 30% probability level.

(P(C<sub>2</sub>H<sub>5</sub>)<sub>3</sub>).<sup>11</sup> Of particular significance, the Ni-C(27) bond of length 2.056(4) Å in complex **2** is significantly shorter than the average Ni-C bonds (average 2.115(4) Å); it is assumed that the steric effect of the Te atom on the metal-bound cyclopentadiene atoms causes significant bonding between Ni and C(27) atoms (the bond angle of Te-Ni-C(27) 163.92(2)°).

In these reactions the complex *fac*-[Fe(CO)<sub>3</sub>(TePh)<sub>3</sub>]<sup>-</sup> acts as a potential chelating metallo ligand", and the chelating property of the iron(II) telluroate complex offers novel routes toward heterometallic telluroate species. This investigation also indicated that the *fac*-[Fe(CO)<sub>3</sub>(SePh)<sub>3</sub>]<sup>-</sup> may serve as a better tridentate metallo ligand and chalcogenolate ligand-transfer reagent than *fac*-[Fe(CO)<sub>3</sub>(TePh)<sub>3</sub>]<sup>-</sup> in the syntheses of heterometallic chalcogenolate complexes.

## EXPERIMENTAL SECTION

Manipulations, reactions, and transfers of samples were conducted under nitrogen according to standard Schlenk techniques or in a glovebox (argon gas). Solvents were distilled under nitrogen from appropriate drying agents (diethyl ether from CaH<sub>2</sub>; acetonitrile from CaH<sub>2</sub>-P<sub>2</sub>O<sub>5</sub>; hexane and tetrahydrofuran (THF) from Na-benzophenone) and stored in dried, N<sub>2</sub>-filled flasks over 4 Å molecular sieves. A nitrogen purge was used on these solvents before use and transfers to reaction vessels were *via* stainless-steel cannula under N<sub>2</sub> at a positive pressure. The reagents manganese decacarbonyl, iron pentacarbonyl, diphenyl ditelluride, bis(triphenylphosphoranylidene)ammonium chloride (Aldrich) were used as received. Infrared spectra were recorded on (Bio-Rad FTS-185 and FTS-7 FTIR spectrometer) with sealed solution cells (0.1 mm) and KBr windows, NMR spectra on a Bruker AC 200 spectrometer, <sup>1</sup>H and <sup>13</sup>C chemical shifts being relative to tetramethylsilane and UV/VIS spectra on a GBC 918 spectrophotometer. Analyses of carbon, hydrogen were obtained with a CHN analyzer (Heraeus).

### Preparation of (CO)<sub>3</sub>Mn(μ-TePh)<sub>3</sub>Fe(CO)<sub>3</sub> (**1**)

A solution containing *fac*-[PPN][Fe(CO)<sub>3</sub>(TePh)<sub>3</sub>] (1 mmol, 1.29 g)<sup>6</sup> and [Mn(CO)<sub>3</sub>(CH<sub>3</sub>CN)<sub>3</sub>][PF<sub>6</sub>] (1 mmol, 0.407 g)<sup>7</sup> in THF (3 mL) was stirred under nitrogen at ambient temperature. After stirring of the reaction solution overnight, the orange purple solution accompanied by a gray precipitate, presumably [PPN][PF<sub>6</sub>], was formed. Diethyl ether (5 mL) was added into the orange purple solution and then the solution was filtered to remove [PPN][PF<sub>6</sub>]. The filtrate was dried under vacuum and then diethyl ether (5 mL)-hexane (3 mL) were added to extract the brown purple solid. The mixture solution was then stored still at room temperature for two days to

Table 2. Selected Bond Distances (Å) and Angles (deg) for (a) **1**, (b) **2**

(a) <b>1</b>			
Fe-Te(1)	2.628(1)	Mn-Te(1)	2.638(1)
Fe-Te(2)	2.640(1)	Mn-Te(2)	2.678(1)
Fe-Te(3)	2.623(1)	Mn-Te(3)	2.646(1)
Fe-Te(1)-Mn	82.26(3)	Te(1)-Fe-Te(2)	79.83(3)
Fe-Te(2)-Mn	81.29(3)	Te(1)-Fe-Te(3)	84.04(3)
Fe-Te(3)-Mn	82.21(3)	Te(1)-Fe-C(1)	93.6(3)
Te(1)-Mn-Te(2)	78.97(3)	Te(1)-Fe-C(2)	89.69(22)
Te(1)-Mn-Te(3)	83.40(3)	Te(1)-Fe-C(3)	168.0(3)
Te(1)-Mn-C(4)	93.43(24)	Te(1)-Mn-C(5)	93.22(23)
Te(1)-Mn-C(6)	172.99(22)		
(b) <b>2</b>			
Ni-Te	2.4804(6)	Ni-C(25)	2.117(4)
Ni-C(26)	2.113(4)	Ni-C(27)	2.056(4)
Ni-C(28)	2.124(4)	Ni-C(29)	2.104(4)
Te-Ni-P	92.69(3)	Te-Ni-C(25)	104.45(13)
Te-Ni-C(26)	135.98(15)	Te-Ni-C(27)	163.92(12)
Te-Ni-C(28)	127.41(15)	Te-Ni-C(29)	99.65(13)

precipitate the pure brown purple solid  $(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Fe}(\text{CO})_3$ . The yield was 0.717 g (80%). Diffusion of hexane into  $(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Fe}(\text{CO})_3$  diethyl ether solution at  $-15^\circ\text{C}$  for 4 weeks led to formation of orange purple crystals of complex **1** suitable for X-ray crystallography. IR (THF):  $\nu(\text{CO})$  2063 m, 2003 vs, 1923 m,  $\text{br cm}^{-1}$ .  $^1\text{H NMR}$  ( $\text{CD}_2\text{Cl}_2$ ):  $\delta$  7.24–7.88 (m) ppm (Ph).  $^{13}\text{C NMR}$  ( $\text{CD}_2\text{Cl}_2$ ):  $\delta$  204.93 ppm (Fe-CO), 138.30 (s), 129.81 (s), 129.54 (s), 105.25 (s) ppm (Ph). Absorption spectrum (THF) [ $\lambda_{\text{max}}$ , nm ( $\epsilon$ ,  $\text{M}^{-1}\text{cm}^{-1}$ ): 385 (3245), 534 (890)]. Anal. Calcd for  $\text{C}_{24}\text{H}_{15}\text{O}_6\text{Te}_3\text{FeMn}$ : C, 32.28; H, 1.69. Found: C, 32.18; H, 1.75.

#### Preparation of $\text{CpNi}(\text{TePh})(\text{PPh}_3)$ (**2**)

A solution of  $[\text{Na}][\text{TePh}]$  (obtained from reaction of  $[\text{Na}][\text{BH}_4]$  (1 mmol, 0.038 g) and  $(\text{TePh})_2$  (1 mmol, 0.410 g) in MeOH) in 15 mL of MeOH was added to  $\text{CpNi}(\text{I})(\text{PPh}_3)$  (1 mmol, 0.513 g) under nitrogen at ambient temperature. After stirring of the reaction solution for 1 h, the brown solution accompanied by a red brown precipitate was formed. The solution was removed under positive  $\text{N}_2$  and then the red brown solid was washed with MeOH twice. The yield of complex **2** was 0.438 g (74%). Diffusion of hexane into  $\text{CpNi}(\text{TePh})(\text{PPh}_3)$  THF solution at  $-15^\circ\text{C}$  for 5 weeks led to formation of crystals of complex **2** suitable for X-ray crystallography.  $^1\text{H NMR}$  ( $\text{C}_4\text{D}_8\text{O}$ ):  $\delta$  4.99 (s) ppm (Cp).  $^{13}\text{C NMR}$  ( $\text{C}_4\text{D}_8\text{O}$ ):  $\delta$  93.96 (s) ppm (Cp). Anal. Calcd for  $\text{C}_{29}\text{H}_{25}\text{PTeNi}$ : C, 58.95; H, 4.27. Found: C, 59.27; H, 4.49.

#### Reaction of $\text{fac-}[\text{Fe}(\text{CO})_3(\text{TePh})_3]^-$ and $\text{CpNi}(\text{I})(\text{PPh}_3)$

A solution of  $\text{fac-}[\text{Fe}(\text{CO})_3(\text{TePh})_3]^-$  (0.4 mmol, 0.516 g) in THF (5 mL) was stirred with  $\text{CpNi}(\text{I})(\text{PPh}_3)$  (0.4 mmol, 0.206 g) overnight at ambient temperature, resulting in the formation of a red brown solution and the solvent-insoluble gray solid  $[\text{PPN}][\text{I}]$ , and an unidentified solid. The red brown solution was transferred into another flask and dried under vacuum. Hexane was added to extract the neutral hexane-soluble product identified as the known  $\text{Fe}_2(\text{CO})_6(\mu\text{-TePh})_2$  by IR (IR  $\nu_{\text{CO}}$  (hexane) 2056 m, 2021 vs, 1980 m, 1962 sh). The hexane-insoluble red brown solid was washed twice with hexane and identified as the neutral  $\text{CpNi}(\text{TePh})(\text{PPh}_3)$  (yield 11%).

#### Crystallography

Crystallographic data for complexes **1**, and **2** are collected in Table 1 and in the Supporting Information. All crystals were chunky: **1**, brown, ca.  $0.30 \times 0.30 \times 0.50$  mm; **2**, dark brown,  $0.55 \times 0.50 \times 0.40$  mm. Each was mounted on a glass fiber and quickly coated in epoxy resin. The unit-cell parameters were obtained by the least-square refinement from 25 reflections with  $2\theta$  between  $18.82$  and  $28.14^\circ$  for **1** and between  $18.90^\circ$  and  $29.22^\circ$  for **2**. Diffraction measurements for complexes **1** and **2** were carried out at  $23^\circ\text{C}$  on a Nonius CAD 4 diffractometer with graphite-monochromated  $\text{Mo K}\alpha$  radiation ( $\lambda$  0.7107 Å) employing the  $\theta$ - $2\theta$  scan mode.<sup>12</sup> A  $\psi$ -scan absorption correction was made. In the structure determination, the positions of Fe and Mn atoms are determined on the basis of the synthetic route, not from the X-ray diffraction data for complex **1**. The NRCC-SDP-VAX package of programs was employed and atomic scattering factors were from ref. 13.

#### ACKNOWLEDGMENT

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#### Key Words

Tellurolate; Heterodimetallic tellurolate.

#### Supporting Information Available

Tables of crystal data and experimental conditions for the X-ray studies, atomic coordinates and  $B_{eq}$  values, bond lengths and angles for  $(\text{CO})_3\text{Mn}(\mu\text{-TePh})_3\text{Fe}(\text{CO})_3$ , and



CpNi(TePh)(PPh<sub>3</sub>) (11 pages). Ordering information is on any current masthead page.

## REFERENCES

1. (a) Arnold, J. *Prog. Inorg. Chem.* **1995**, *43*, 353. (b) Brewer, M.; Khasnis, D.; Buretea, M.; Berardini, M.; Emge, T. J.; Brennan, J. G. *Inorg. Chem.* **1994**, *33*, 2743. (c) McGregor, K.; Deacon, G. B.; Dickson, R. S.; Fallon, G. D.; Rowe, R. S.; West, B. *J. Chem. Soc., Chem. Commun.* **1990**, *19*, 1293. (d) Piers, W. E.; Ferguson, G.; Gallagher, J. F. *Inorg. Chem.* **1994**, *33*, 3784.
2. (a) Roof, L. C.; Kolis, J. W. *Chem. Rev.* **1993**, *93*, 1037. (b) Ansari, M. A.; Ibers, J. A. *Coord. Chem. Rev.* **1990**, *223*. (c) Cheng, Y.; Emge T. J.; Brennan J. G. *Inorg. Chem.* **1996**, *35*, 7339. (d) Hirpo, W.; Dhingra, S.; Sutorik, A.; Kanatzidas, M. *J. Am. Chem. Soc.* **1993**, *115*, 1597.
3. Liaw, W.-F.; Horng, Y.-C.; Ou, D.-S.; Ching, C.-Y.; Lee, G.-H.; Peng, S.-M. *J. Am. Chem. Soc.* **1997**, *119*, 9299.
4. Liaw, W.-F.; Chen, C.-H.; Lee, C.-M.; Lin, G.-Y.; Ching, C.-Y.; Lee, G.-H.; Peng, S.-M. *J. Chem. Soc., Dalton Trans.* **1998**, 353.
5. Liaw, W.-F.; Lee, C.-M.; Horng, L.; Lee, G.-H.; Peng, S.-M. *Organometallics* **1999**, *18*, 782.
6. Liaw, W.-F.; Chiang, M.-H.; Liu, C.-J.; Harn, P.-J. *Inorg. Chem.* **1993**, *32*, 1536.
7. Drew, D.; Darensbourg, D. J.; Darensbourg, M. Y. *Inorg. Chem.* **1975**, *14*, 1579.
8. Liaw, W.-F.; Ou, D.-S.; Li, Y.-S.; Lee, W.-Z.; Chuang, C.-Y.; Lee, Y.-P.; Lee, G.-H.; Peng, S.-M. *Inorg. Chem.* **1995**, *34*, 3747.
9. Walters, M. A.; Dewan, J. C. *Inorg. Chem.* **1986**, *75*, 4889.
10. Schermer, E. D.; Baddley, W. H. *J. Organomet. Chem.* **1971**, *30*, 67.
11. Schneider, J. J.; Kuhnigkh, J.; Krüger, C. *Inorg. Chim. Acta* **1997**, *266*, 109.
12. North, A. C. T.; Philips, D. C.; Mathews, F. S. *Acta Cryst.* **1968**, *A24*, 351.
13. (a) Gabe, E. J.; LePage, Y.; Charland, J. P.; Lee, F. L.; White, P. S. *J. Appl. Crystallogr.* **1989**, *22*, 384. (b) *International Tables for X-Ray Crystallography*; Kynoch Press: Birmingham, **1974**, vol. 4.



