# Processing double refractory gold-arsenic-bearing concentrates by direct reductive melting.

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## Supplementary material

Table 1: Reference thermodynamic characteristics of the reactants relevant to the furnace charge

| Phase | $\Delta H^0_{298}$ | $S^0_{298}$ | $C_{P_{298}}$ | $C_p = a + bT + cT^{-2}$, J/(mol K) | | | $T, K$ |
|---|---|---|---|---|---|---|---|
| | | | | $a$ | $b \times 10^{-3}$ | $c \times 10^5$ | |
| $As_4$ (g) | 143.68 | 329.70 | 77.40 | 83.07 | - | -5.02 | 298-2000 |
| $As_2$ (g) | 193.80 | 242.37 | 35.13 | 37.39 | - | -2.18 | 298-2000 |
| $As_4S_4$ (g) | -5.44 | 451.45 | 164.01 | 177.44 | 7.95 | -13.81 | 298-1073 |
| $As_2O_3$ (g) | -656.89 | 107.11 | | 35.04 | 203.5 | - | 273-548 |
| FeAsS* (s) | -137.03 | 67.95 | 68.49 | 62.88 | 40.55 | -1.42 | 298-975 |
| FeS (s) | -100.42 | 60.29 | 50.54 | 51.04 | 9.95 | - | 598-1468 |
| $FeS_2$ (s) | -163.18 | 53.05 | 62.17 | 74.81 | 5.52 | -12.76 | 298-1100 |
| $S_2$ (g) | 127.52 | 228.04 | 35.73 | 36.48 | 0.67 | -3.77 | 298-3000 |
| Fe (s) | 0 | 27.15 | 24.98 | 17.50 | 24.79 | - | 273-1033 |
| $FeAs_2$* (s) | -85.73 | 80.21 | 70.88 | 76.15 | 3.92 | 3.97 | 298-1173 |
| $Fe_2As$** (s) | -4.60 | 144.64 | 72.93 | 76.74 | 0.48 | 3.92 | 298-1173 |
| FeAs* (s) | -43.47 | 60.00 | 50.58 | 35.32 | 44.06 | 7.14 | 298-1173 |
| FeO(s) | -265.0 | 60.79 | 49.95 | 51.83 | 6.78 | -1.59 | 298-1200 |
| PbO (s) | -219.43 | 66,20 | 45.80 | 37.89 | 26.79 | - | 298-1000 |
| Pb (s) | 0 | 64.85 | 26.46 | 23.57 | 9.76 | - | 273-600 |
| C (s) | 0 | 5.74 | 8.54 | 17.17 | 4.27 | -8.79 | 298-2300 |
| CO (g) | -110.60 | 197.68 | 29.132 | 28.43 | 4.10 | -0.46 | 298-2500 |
| $CO_2$ (g) | -393.77 | 213.82 | 37.14 | 44.17 | 9.04 | -8.54 | 298-2500 |
| $SO_2$ (g) | -296.90 | 248.07 | 39.87 | 46.19 | 7.87 | -7.7 | 298-2000 |

All from [1], * - from [2], ** - from [3]

Table 2: Crystallographic data

| Phase | Chemical formula | Space group | ICSD collection code | Reference |
|---|---|---|---|---|
| Iron arsenide (2/1) | $Fe_2As$ | P4/n m m | 415628 | [4] |
| Iron (III) arsenide | FeAs | P n a 21 | 15009 | [5] |
| Iron sulfide | FeS | P-6 2 c | 31963 | [6] |
| Arsenic sulfide | AsS | C 1 2/c 1 | 86628 | [7] |
| Lead | Pb | F m -3 m | 46501 | [8] |
| Iron (III) oxide | $Fe_2O_3$ | R -3 c H | 15840 | [9] |
| Iron (II) oxide | FeO | F m -3 m | 82233 | [10] |
| Arsenopyrite | FeAsS | C 1 1 21/d | 62400 | [11] |
| Pyrite | $FeS_2$ | P a -3 | 152784 | [12] |
| Graphite | C | P 63/m m c | 76767 | [14] |
| Quartz | $SiO_2$ | P 32 2 1 | 89276 | [16] |
| Wollastonite | $Ca_{0.97}Mn_{0.03}(SiO_3)$ | C -1 | 34168 | [17] |
| Muscovite | $(K_{0.93}Na_{0.03})(Al_{1.54}Fe_{0.25}Mg_{0.21}Ti_{0.04})(Si_{3.34}Al_{0.66})O_{10}(OH)_2$ | P 31 1 2 | 75952 | [13] |
| Sericite | $(Ca_{0.01}K_{0.73}Na_{0.17})(Al_{1.83}Fe_{0.03}Mg_{0.02})(Si_{3.10}Al_{0.88}Ti_{0.02})O_{10}(OH)_2$ | 1 2/c 1 | 87447 | [15] |

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