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C-Fe-Mn-Mo (Carbon-Iron-Manganese-Molybdenum)

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The previous review of this system by [1996Rag] gave a tentative isothermal section for Fe-rich alloys at 1000 °C and at C activity of 0.193. Recently, [2003Gom] computed the liquid-solid equilibria in the C-Cr-Fe-Mn-Mo quinary system and during the course of this work, presented a reaction scheme for the solidification region of this quaternary system.

Binary Systems

For the six binary subsystems of C-Fe, C-Mn, C-Mo, Fe-Mn, Fe-Mo and Mn-Mo, [2003Gom] computed the minimum melting temperature and the corresponding composition and compared them the liquid-solid data from [Massalski2]. They listed the published assessments from literature sources used in the computation.

Ternary Systems

For the four ternary systems C-Fe-Mn, C-Fe-Mo, C-Mn-Mo and Fe-Mn-Mo, [2003Gom] computed the minimum melting composition and temperature, using the parameters from previous assessments and compared the same with the data reviewed by [1988Ray] and other unpublished sources.

Quaternary Phase Equilibria

Employing Thermo-Calc software, [2003Gom] computed the phase equilibria and plotted projections of the univariant liquidus lines, with the liquid composition of one of the elements as the *x*-axis and the temperature as the *y*-axis. When no univariant line lies below the point of intersection of the liquidus lines, the point represents the minimum-melting liquid composition. This conclusion was verified by calculating an isothermal section just below the minimum temperature and checking that no liquid is present in any of the phase fields. The topology of the liquidus lines in Fig. 1 indicates the type of the quaternary invariant reaction taking place at the point of intersection (indicated by a dot) [2003Gom]. Four possible configurations of the univariant liquidus lines are shown. The broken horizontal lines passing through the dots correspond to the five-phase invariant planes. In the quaternary eutectic reaction (Fig. 1a), four univariant liquidus lines lie above and none below the invariant plane. In the $U^{2 \rightarrow 3}$ transition reaction [1993Rag], three liquidus lines are above and one below the plane (Fig. 1b). In the $U^{3 \rightarrow 2}$ transition reaction, two liquidus lines are above and two are below the plane (Fig. 1c). In the quaternary peritectic reaction (Fig. 1d), one liquidus line is above and three are below the invariant plane.

[2003Gom] computed a reaction scheme for the C-Fe-Mn-Mo system, which is shown in Fig. 2. The five-phase invariant reactions are denoted in bold italics, e.g., $\boldsymbol{U_1}$. The numbering order adopted by [2003Gom] is indicated at the top right corner of the box. The phase denoted as χ by [2003Gom] is labeled here as ξ (Fe_2MoC). For consistency, the reactions $\boldsymbol{U_1}$ (denoted 12 by [2003Gom]), $\boldsymbol{U_6}$ (denoted 5 by [2003Gom]), and $\boldsymbol{U_8}$ (denoted 9 by [2003Gom]) are rewritten as shown. In Fig. 2, any product univariant equilibrium emerging from the five-phase invariant plane containing all solid phases is omitted. The minimum melting temperature and alloy composition (in wt.%) are 1036 °C and Fe-3.99C-21.4Mn-10.4 Mo respectively [2003Gom]. This is also the minimum melting composition for the quinary system C-Cr-Fe-Mn-Mo, as the addition of Cr increases the melting temperature.

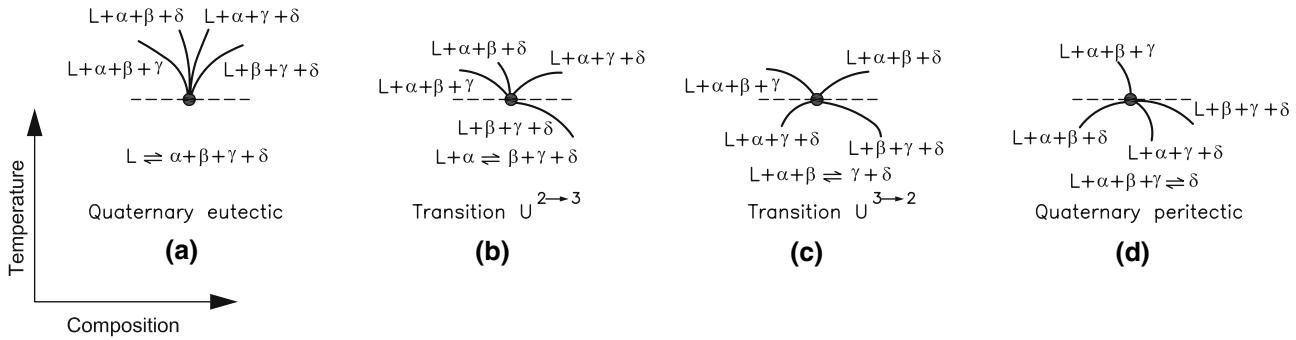

Fig. 1 Schematic projections of the univariant liquidus lines as a function of temperature and composition of liquid [2003Gom]

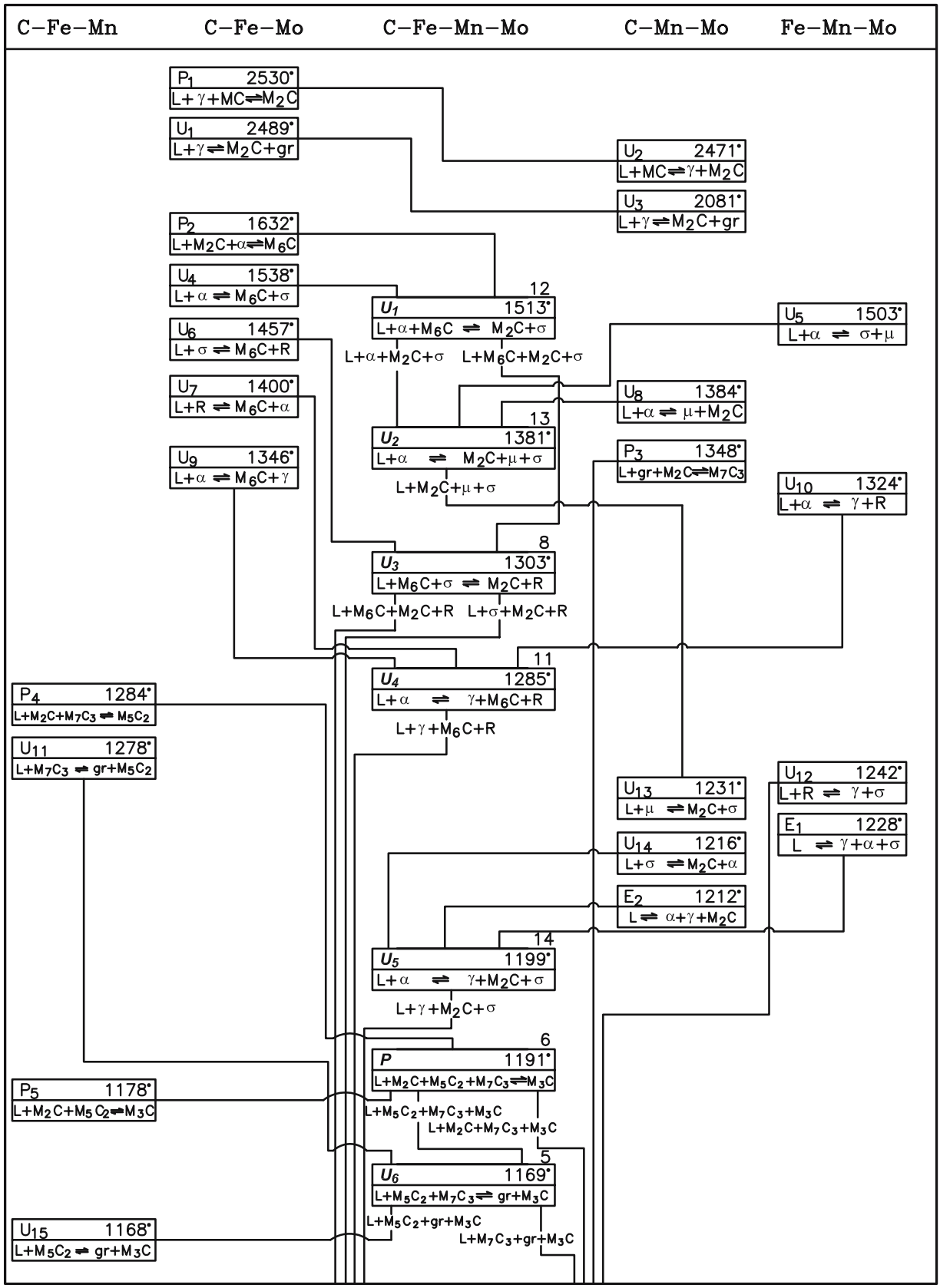

Fig. 2 C-Fe-Mn-Mo computed sequence of liquid-solid reactions [2003Gom] (two sheets)

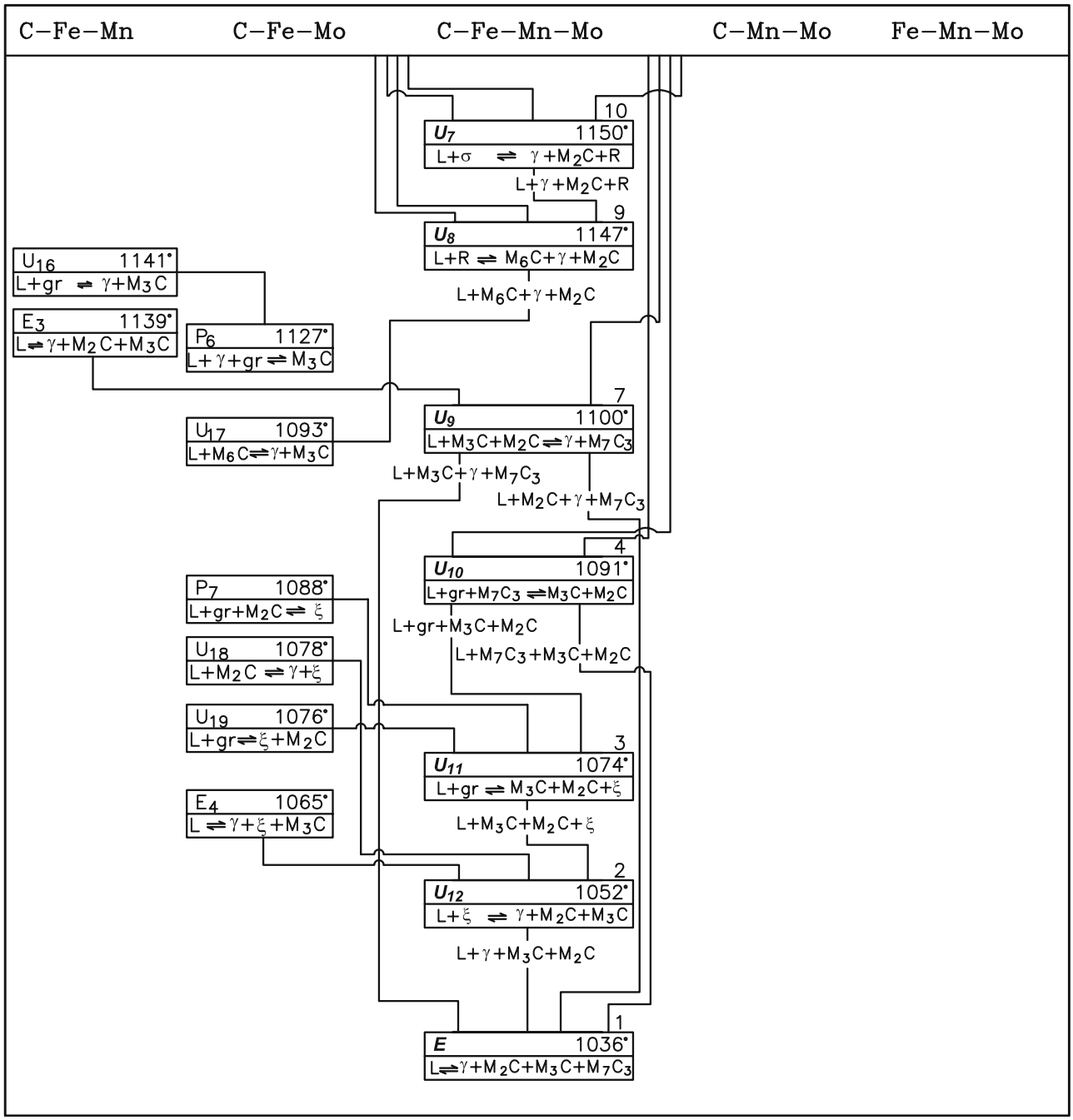

Fig. 2 continued

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