

## RICHARD JAMES FRUEHAN

### Publications

1. "The Thermodynamic Properties of Various Liquid Ferrous Alloys Determined by a Mass Spectrometer": R. J. Fruehan, Ph.D. Thesis, University of Pennsylvania, Philadelphia, 1966.
2. "The Determination of Activities by Mass Spectrometry. I. The Liquid Metallic Systems Iron-Nickel and Iron-Cobalt": G.R. Belton and R.J. Fruehan, *J. Phys. Chem.* 71, 1403 (1967).
3. "The Activity of Cr in Liquid Ni-Cr Alloys": R. J. Fruehan, *Trans. Met. Soc., AIME*, 242, 2007 (1968).
4. "Rapid Oxygen Determination in Liquid Steel": E. T. Turkdogan and R. J. Fruehan, AISI General Mtg., May 22-23, 1968, N.Y.; Yearbook of AISI, pp. 279-302.
5. "Mass Spectrometric Determination of the Activities in Fe-Al and Ag-Al Liquid Alloys": G. R. Belton and R. J. Fruehan, *Trans. Met. Soc. AIME* 245, 113 (1969).
6. "Thermodynamic of Binary Metallic Solutions. Part III.": E. T. Turkdogan, R. J. Fruehan, and L. S. Darken, *Trans. Met. Soc. AIME*, 245, 1003 (1969).
7. "Activities in the Liquid Fe-Cr-O System": R. J. Fruehan, *Trans. Met. Soc. AIME*, 245, 1215 (1969).
8. "Development of a Galvanic Cell for the Determination of Oxygen in Liquid Steel": R. J. Fruehan, L. J. Martonik, and E. T. Turkdogan, *Trans. Met. Soc. AIME*, 245, 1215 (1969).
9. "Development of a Galvanic Cell for the Determination of Oxygen in Liquid Steel": R. J. Fruehan, L. J. Martonik, and E. T. Turkdogan, *Trans. Met. Soc. AIME*, 245, 1501 (1969).
10. "The Activities of Oxygen in Liquid Copper and it's Alloys with Silver and Tin": R. J. Fruehan and F. D. Richardson, *Trans. Met. Soc. AIME*, 245, 1721 (1969).
11. "The Thermodynamic Properties of Liquid Fe-Si Alloys": R. J. Fruehan, *Metall. Trans.* 1, 865 (1970).

12. "Mass Spectrometric Determination of Activities in Liquid Iron-Chromium and Iron-Chromium-Nickel Alloys": G. R. Belton and R. J. Fruehan, *Metall. Trans.*, 1, 781, 1970.
13. "Activities in Liquid Fe-V-O and Fe-B-O Alloys": R. J. Fruehan, *Metall. Trans.*, 1, 2803 (1970).
14. "Activities in Liquid Fe-Al-O and Fe-Ti-O Alloys": R. J. Fruehan, *Metall. Trans.*, 1, 3403, 1970.
15. "Desulfurization of Iron Alloys in Vacuo-Free Energy of Formation of SiS(v)": R. J. Fruehan and E. T. Turkdogan, *Metall. Trans.*, 2 895 1971.
16. "The Determination of Activities by Mass Spectrometry-Some Additional Methods": G. R. Belton and R. J. Fruehan, *Metall. Trans.*, 2, 291 1971.
17. "Mass Spectrometric Determination of Activities for Alloys with Complex Vapor Species: Bi-Pb and Bi-Ti": R. J. Fruehan, *Metall. Trans.*, 2, 1213, 1971.
18. "The Rate of Decarburization of Austenite in CO-CO<sub>2High Temp. Sci., Vol. 2, No. 3, 244, 1971.</sub>
19. "Probing for More than Temperature": C. K. Russell, R. J. Fruehan and R. S. Rittiger, *J. Metals*, Vol. 23, No. 11, 44, 1971.
20. "Rate of Removal of Sulfur from Liquid Iron Alloys in Vacuo: Free Vaporization of S and S<sub>2Metall. Trans., 3, 596, 1972.</sub>
21. "Review of Oxygen Sensors for Use in Steelmaking and of Deoxidation Equilibria": E. T. Turkdogan and R. J. Fruehan, *Can. Met. Qtrly*, Volume 11, No. 2, 371, 1972.
22. "The Effect of Sulfur and Phosphorus on the Rate of Decarburization of Solid Iron in Hydrogen": R. J. Fruehan, *Metall. Trans.*, 3, 1447 (1972)
23. "The Rate of Chlorination of Metals and Oxides: Part I. Iron, Nickel, and Tin in Chlorine": R. J. Fruehan, *Metall. Trans.*, Vol. 3, 1972, pp. 2585-92.
24. "The Rate of Carburization on Iron in CO-H<sub>2</sub> Atmospheres: Part II. Effect of H<sub>2</sub>O and H<sub>2</sub>S": R. J. Fruehan, *Metall. Trans.*, Vol. 4, 1973, pp. 2129-32.
25. "The Rate of Chlorination of Metals and Oxides: Part II. Iron and Nickel in HCl": R. J.

Fruehan and L. J. Martonik, *Metall. Trans.*, Vol. 4, 1973, pp. 2789-92.

26. "The Rate of Chlorination of Metals and Oxides; Part III.  $\text{Fe}_2\text{O}_3$  and  $\text{NiO}$  in  $\text{Cl}_2$  and  $\text{HCl}$ ": R. J. Fruehan and L. J. Martonik, *Metall. Trans.*, Vol. 4, 1973, pp. 2793-97.
27. "The Effect of Zirconium, Cerium, and Lanthanum on the Solubility of Oxygen in Liquid Iron": R. J. Fruehan, *Metall. Trans.*, Vol. 5, 1974, pp. 345-47.
28. "The Rate of Decarburization of Liquid Iron by  $\text{CO}_2$  and  $\text{H}_2Metall. Trans., Vol. 5, 1974, pp. 1027-31.$
29. "Solubilities of Cerium and Lanthanum Sulfides in Iron and Steel": R. J. Fruehan and E. T. Turkdogan, *Sulfide Inclusions in Steel*, No. 6, American Society of Metals, pp. 21-22, 1974.
30. "Nitrogenation and Decarburization of Stainless Steel": R. J. Fruehan, *Metall. Trans. B*, Vol. 6B, 1975, pp. 573-78.
31. "The Rates of Several Gas-Liquid Reactions in the Q-BOP": R. J. Fruehan, Ironmaking and Steelmaking, 1976, No. 1, pp. 33-38.
32. "Reaction Model for the AOD Process": R. J. Fruehan, Ironmaking and Steelmaking, 1976, No. 3, pp. 153-58.
33. "The Rate of Reduction of  $\text{MgO}$ " by Carbon": R. J. Fruehan and L. J. Martonik, *Metall. Trans. B*, 1976, Vol. 7B, pp. 537-42.
34. "The Rate of Reduction of Iron Oxides by Carbon": R.J. Fruehan, *Metall. Trans. B*, 1977, Volume 8B, pp. 279-86.
35. "Rate of Reduction of  $\text{Cr}_2\text{O}_3$  by Carbon and Carbon Dissolved in Liquid Iron Alloys": R. J. Fruehan, *Metall. Trans. B*, 1977, Volume 89, pp. 429-33.
36. "Reaction Between Condensed Phases Involving Gases": E. T. Turkdogan, R.J. Fruehan and R.H. Tien, *Proc. Darken Conference*, U.S. Steel Research Laboratory, 1976, pp. 147-75.
37. "Desulfurization of Steel Containing Si or Al by  $\text{CaO}Metall. Trans. B, 1978.$
38. "Physical Behavior and Liquid-Phase Mass Transfer of Submerged Gas Jets in Liquids": R.J. Fruehan and L.J. Martonik, *Proc. Third Int. Iron and Steel Congress*, Chicago, 1978.

39. "The Free Energy of Formation of Ce<sub>2</sub>O<sub>2</sub>S and the Nonstoichiometry of Cerium Oxides": R.J. Fruehan, *Metall. Trans. B*, 1979, Vol. 10B, pp. 143-47.
40. "The Rate of Mass Transfer Between Submerged Gas Jets and Liquid Metals": R. J. Fruehan, *Metals Technology*, 1980, pp. 95-101.
41. "The Rate of Absorption of Nitrogen into Liquid Iron Containing Oxygen and Sulfur": R. J. Fruehan and L. J. Martonik, *Metall. Trans. B*, Vol. 11B, 1980, p. 625.
42. "Studies of Several Reactions in the Blast Furnace": E. T. Turkdogan, G. J. W. Kor and R. J. Fruehan, *Iron and Steelmaking*, Vol. 6, 1980, pp. 268-80.
43. "The Physical Chemistry of Ironmaking and Steelmaking": R. J. Fruehan and E.T. Turkdogan, *The Making, Shaping and Treating of Steel*, U.S. Steel Corporation, 1981.
44. "The Rate of Absorption of Nitrogen into Fe-Cr and Fe-Ni-Cr Alloys": R. J. Fruehan and L. J. Martonik, *Metall. Trans. B*, Vol. 12B, 1981, pp. 379-84.
45. "The Phosphorous Reaction in Oxygen Steelmaking": R. J. Fruehan, Proceedings of the Steelmaking Conference of ISS of AIME, Pittsburgh PA, March 1981.
46. "Ladle Treatment for Continuously Cast Steels": R. J. Fruehan, Proceedings of the 4th International Iron and Steel Congress, London UK, May 1982.
47. "Thermochemistry of Desulfurization of Hot Metal with Lime-Based Injection": P. J. Koros and R. J. Fruehan, Proceedings of International Symposium of the Physical Chemistry of Iron and Steelmaking, Toronto Canada 1982.
48. "The Rate of Absorption of Nitrogen into Liquid Fe and Fe-Cr Alloys": R. J. Fruehan and P. C. Glaws, Proceedings of International Symposium of the Physical Chemistry of Iron and Steelmaking, Toronto Canada, 1982.
49. "Several Aspects of Slag-Metal Reactions in the Blast Furnace": R.J. Fruehan, Proceedings of International Symposium of the Physical Chemistry of Iron and Steelmaking, Toronto Canada, 1982.
50. "Thermodynamics and Kinetics of Reactions Involving Elements in Ladle Metallurgy": R. J. Fruehan, Proceedings of Electric Furnace Conference, Kansas City, December 1982, and *Iron and Steelmaker*, 1983, pp. 33-38.
51. "Thermodynamic and Kinetic Considerations in Hot Metal Treatments": R. J. Fruehan, J. C. Niedringhaus and A. H. Chan, *Steelmaking Proceedings*, 1984, p. 269.

52. "Physical Modelling of Mixed Gas Blowing Processes": R. Matway, H. Henein, R. J. Fruehan, and J. Isaacs, Proceedings of the Process Technology Conference, 1984, p. 39.
53. "Kinetics of Coupled Slag-Metal Reactions in Iron": R. J. Fruehan and S. Bhagavatula, *ISS Transactions*, 1984, Vol. 4, p. 11.
54. "Kinetics of the Reaction of SiO(g) with Carbon Saturated Iron": B. Ozturk and R. J. Fruehan, *Metall. Trans. B*, Vol. 16B, 1985, p. 121.
55. "Scrap in Iron and Steelmaking": R.J. Fruehan, *Iron and Steelmaker*, May 1985, p. 30.
56. "Scrap in Iron and Steelmaking - Technologies to Improve the Use of Scrap": R.J. Fruehan, *Iron and Steelmaking*, July 1985, p. 31.
57. "The Kinetics of the Nitrogen Reaction with Liquid Iron-Sulfur Alloys": P. C. Glaws and R. J. Fruehan, *Metall. Trans. B*, Vol. 16B, 1985, p. 551.
58. "The Rate of Formation of SiO by the Reaction of CO and H<sub>2</sub> with Silica and Silicate Slags": B. Ozturk and R. J. Fruehan, *Metall. Trans. B*, Vol. 16B, 1985, pp. 801-806.
59. "Ladle Refining Furnaces for the Steel Industry": R. J. Fruehan, Center for Materials Production, Report 85-1, March 1985.
60. "Plasma Processes for Metals Production": R. J. Fruehan, Center for Materials Production, Report 853, October 1985.
61. "The Thermodynamics and Process Dynamics of Ladle Furnace Refining Processes": R. J. Fruehan, *Transactions of the Iron and Steel Society*, Vol. 6, 1985, p. 43.
62. "The Thermodynamics and Process Dynamics of Ladle Furnace Refining Processes": R. J. Fruehan, Proceedings of the Electric Furnace Conference, Toronto, 1984, Vol. 42.
63. "The Reaction of SiO(g) with Liquid Slags": B. Ozturk and R. J. Fruehan, *Metall. Trans. B*, Volume 17B, 1986, p. 397.
64. "Kinetics of Nitrogen Reaction with Iron-Chromium Alloys": P. C. Glaws and R. J. Fruehan, *Metall. Trans. B*, vol. 17B, 1986, p. 317.
65. "The Nitrogen Reaction Between Carbon Saturated Iron and Na<sub>2</sub>O-SiO<sub>2</sub> Slags, Part I": F. Tsukihashi and R. J. Fruehan, *Metall. Trans. B*, Volume 17B, 1986, p. 467.

66. "The Nitrogen Reaction between Carbon Saturated Iron and Na<sub>2</sub>O-SiO<sub>2</sub> Slags, Part II Kinetics": F. Tsukihashi and R. J. Fruehan, *Metall. Trans. B*, Volume 17B, 1986, p. 541.
67. "The Thermodynamics of Sulfur and Phosphorus Reactions Between Carbon Saturated Iron and N<sub>2</sub>O-SiO<sub>2</sub> Slags": A. H. Chan, J. J. Pak and R. J. Fruehan, Proceedings of the Fifth International Iron and Steel Congress, PTD, Washington D.C., 1986, p. 467.
68. "A Model for Nitrogen Absorption in Iron Alloy Melts": R. J. Fruehan, B. Lally and P. C. Glaws, Proceedings of the Fifth International Iron and Steel Congress, PTD, Washington D.C., 1986, p. 339.
69. "Equilibrium and Kinetics of the Nitrogen Reaction with Na<sub>2</sub>O-SiO<sub>2</sub> and Carbon Saturated Iron": F. Tsukihashi and R. J. Fruehan, Proceedings of the Fifth International Iron and Steel Congress, PTD, Washington D.C., 1986, p. 713.
70. "Transfer of Silicon in Blast Furnace": B. Ozturk and R. J. Fruehan, Proceedings of the Fifth International Iron and Steel Congress, Washington D.C., 1986, p. 959.
71. "A Control Model for Nitrogen Absorption in Steelmaking Processes": R. J. Fruehan, B. Lally, P. C. Glaws, *Transactions of ISS, I&SM*, April 1987, p. 31.
72. "Soda Slag System for Hot Metal Dephosphorization": J. J. Pak and R. J. Fruehan, *Metall. Trans. B*, Volume 17B, 1987, p. 797.
73. "Formation of SiO(g) and SiS(g) from Coke": B. Ozturk and R. J. Fruehan, *Transactions of ISS of AIME, I&SM*, July 1987, p. 43.
74. "Physical Chemistry of Gas Liquid Solder Reactions": B. Ozturk, P. Barron and R. J. Fruehan, *Metall. Trans. B*, Volume 18B, 1987, p. 381.
75. "Physical Modeling of Liquid/Liquid Mass Transfer in Gas Stirred Ladles": Seon-Hyo Kim and R. J. Fruehan, *Metall. Trans. B*, Volume 18B, 1987, pp. 673-680.
76. "The Thermodynamics and Kinetics of Gas Dissolution and Evolution from Iron Alloys": R. J. Fruehan, Proceedings of Physical Chemistry of Foundry Processes, General Motors Symposium, Warren MI, 1987, pp. 411-422.
77. "Two Phase Mass Transfer in Gas Stirred Reactors", R. J. Fruehan and S-H Kim, Proceedings of Physical Chemistry of Foundry Processes, General Motors Symposium, Warren MI, 1987, pp. 293-302.

78. "Rate of Nitrogen Reaction on Fe-Ni-S and Fe-Cr-N-S Alloys": P. C. Glaws and R. J. Fruehan, *Transactions of ISS*, January 1987, p. 55.
79. "A Study of the Reaction of CO on Liquid Iron Alloys": R. J. Fruehan and S. Antolin, *Metall. Trans. B*, Volume 18B, 1987, p. 415.
80. "Activity of Silica in Calcium-Aluminate Slags": B. Ozturk and R. J. Fruehan, *Metall. Trans. B*, Volume 18B, 1987, p. 746.
81. "Reaction Mechanism for the CaO-Al and CaO-CaF<sub>2</sub> Desulfurization of Carbon Saturated Iron": J. C. Niedringhaus and R. J. Fruehan, Proceedings of 70th Steelmaking Conference, ISS of AIME, 1987, p. 317.
82. "Dynamics of Hot Metal Dephosphorization with Na<sub>2</sub>O<sub>2</sub> Slags": J. J. Pak and R. J. Fruehan, *Met. Trans. B*, Volume 18B, 1987, p. 687-693.
83. "Alternate Scrap Melting Technologies, Part I", R. J. Fruehan, *Iron and Steelmaker*, March 1987, p. 19.
84. "Alternate Scrap Melting Technologies, Part II", R. J. Fruehan, *Iron and Steelmaker*, April 1987, pp. 9-12.
85. "University Research for Improved Electric Arc Furnace Steelmaking and Scrap Utilization": R. J. Fruehan and A. McLean, *Iron and Steelmaker*, October 1987, pp. 11-14.
86. "Effects of CO<sub>2</sub> Stirring in a Ladle": T. Bruce, F. Weisang, M. Allibert, and R. Fruehan, Proceedings of Electric Furnace Conference, ISS of AIME, Chicago IL, 1987, Volume 45, p. 293.
87. "The Kinetics of the Nitrogen Reaction with Carbon Saturated Iron Alloys": F. Tsukihashi and R. J. Fruehan, *Trans. JISI*, Volume 27, 1987, p. 858.
88. "Reaction Mechanism of CaO-Al and CaO-CaF<sub>2</sub> Desulfurization of Carbon Saturated Iron": J. C. Niedringhaus and R. J. Fruehan, *Metall. Trans. B*, Vol. 19B, 1988, pp. 261-268.
89. "The Sulfur Partition Ratio and the Sulfide Capacity of Na<sub>2</sub>O-SiO<sub>2</sub> Slags at 1400°C", Allen H. Chan and R. J. Fruehan, *Metall. Trans. B*, Volume 17B, 1988, pp. 334-336.
90. "Thermodynamics of Copper Removal from Carbon Saturated Iron with FeS-Na<sub>2</sub>S-Cu<sub>2</sub>S Matte", I. Jimbo, M. Sulsky and R. J. Fruehan, 1988 W. O. Philbrook

Memorial Symposium Conference Proceedings, ISS-AIME, Toronto Canada, 1988, p. 133.

91. "The Effect of Na<sub>2</sub>O on the Thermodynamics of Dephosphorization of CaO Based Slags": J. J. Pak and R. J. Fruehan, 1988 W.O. Philbrook Memorial Symposium Conference Proceedings, ISS-AIME, Toronto Canada, 1988, pp. 17-23.
92. "Thermodynamics of Ca-CaF<sub>2</sub>-Ca-CaCl<sub>2</sub> Systems for Dephosphorization of Steel": N. Masumitsu, K. Ito and R. J. Fruehan, 1988 W. O. Philbrook Memorial Symposium Conference Proceedings, ISS-AIME, Toronto Canada, 1988, p. 229.
93. "Slag Foaming in Smelting Reduction Processes": K. Ito and R. J. Fruehan, 1988 Process Technology Conference Proceedings, ISS-AIME, Volume 17, p. 13.
94. "Slag Foaming in Electric Furnace Steelmaking": K. Ito and R. J. Fruehan, Proceedings of the Electric Furnace Conference, ISS-AIME, 1988.
95. "Thermodynamics of Nitrogen in CaO-SiO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> Slags and Its Reaction with Fe-C-(sat) Melts": K. Ito and R. J. Fruehan, 1988 W. O. Philbrook Memorial Symposium Conference Proceedings, ISS-AIME, Toronto Canada, p. 101.
96. "Reaction of Nitrogen with Calcium Aluminate Slags": B. Ozturk and R. J. Fruehan, 1988 W. O. Philbrook Memorial Symposium Conference Proceedings, ISS-AIME, Toronto Canada, p. 119.
97. "Slag Foaming in Smelting Reduction Processes": K. Ito and R. J. Fruehan, 1988 Process Technology Conference Proceedings, ISS-AIME, Volume 7, p. 13.
98. "The Refining of Copper from Ferrous Scrap": I. Jimbo, M. Sulsky and R. J. Fruehan, I&SM, August 1988, pp. 20-23.
99. "Thermodynamics of Ca-CaF<sub>2</sub> and Ca-CaCl<sub>2</sub> Systems for the Dephosphorization of Steel": N. Masumitsu, K. Ito and R. J. Fruehan, *Metall. Trans. B*, vol. 19B, 1988, pp. 643-648
100. "Analysis of Bath Smelting Processes for Producing Iron": R. J. Fruehan, K. Ito, B. Ozturk, *Trans. ISS, I&SM*, November 1988, pp. 83-91.
101. "Gases in Metals": Richard J. Fruehan, Metals Handbook, 9th Edition, Volume 15, ASM International, Metals Park Ohio, pp. 82-87.
102. "Thermodynamics of Nitrogen in CaO-SiO<sub>2</sub>-Al<sub>2</sub>O<sub>3</sub> Slags and Its Reaction with Fe-

$C_{\text{sat}}$  Melts": Kimihisa Ito and R. J. Fruehan, *Metall. Trans. B*, Volume 19B, June 1988, pp. 419-425.

103. "Sulfur Partition Ratio with Fe- $C_{\text{sat}}$  Melts and Sulfide Capacity of CaO-SiO<sub>2</sub>-Na<sub>2</sub>O(Al<sub>2</sub>O<sub>3</sub>) Slags": A. H. Chan and R. J. Fruehan, *Metall. Trans. B*, Volume 20B, February 1989, pp. 71-76.
104. "Physical Modeling of Gas Injection in a Steelmaking Vessel": R. Matway, R. J. Fruehan, H. Henein, *Trans. ISS, I&SM*, September 1989, pp. 51-58.
105. "Decarburization Kinetics of Liquid Fe- $C_{\text{sat}}$  Alloys by CO<sub>2</sub>", F. J. Mannion and R. J. Fruehan, *Metall. Trans. B*, Volume 20B, December 1989, pp. 853-861.
106. "Thermodynamics of Ti, Al and Inclusion Formation in Stainless Steel and Nickel Alloy": L. Liao, R. J. Fruehan, *Trans. ISS, I&SM*, October 1989, pp. 91-97.
107. "Slag Foaming in Electric Furnace Steelmaking", K. Ito and R. J. Fruehan, *Trans ISS, I&SM*, August 1989, pp. 55-60.
108. "Study on the Foaming of CaO-SiO<sub>2</sub>-FeO Slags. Part I Foaming Parameters and Experimental Results": Kimihisa Ito and R. J. Fruehan, *Metall. Trans. B*, Volume 20B, 1989, p. 509.
109. "Study on the Foaming of CaO-SiO<sub>2</sub>-FeO Slags. Part II Dimensional Analysis and Foaming in Iron and Steelmaking Processes": Kimihisa Ito and R. J. Fruehan, *Metall. Trans. B*, Volume 20B, 1989, p. 515.
110. "Physical Modeling of Gas Injection in a Steelmaking Vessel": R. Matway, R. J. Fruehan, H. Henein, *Trans ISS, I&SM*, September 1989, p.51.
111. "Activities of Na<sub>2</sub>O in CaO-Based Slags Used for Dephosphorization of Steel": J.J. Pak, K. Ito and R. J. Fruehan, *ISIJ International*, Volume 29, 1989, p. 318.
112. "Decarburization Kinetics of Liquid Fe- $C_{\text{sat}}$  Alloys by CO<sub>2- 113. "Slag Foaming in Electric Furnace Steelmaking": K. Ito and R. J. Fruehan, *Trans. ISS, I&SM*, August 1989, p. 51.
- 114. "A Non-Technical Introduction to Electric Furnace Steelmaking: Parts I-VI", R. J. Fruehan, *I&SM*, March - August, 1989.</sub>

115. "Thermodynamics of Ti, Al and Inclusion Formation in Stainless Steels and Nickel Alloys": L. Liao and R. J. Fruehan, *Trans. ISS, Iron and Steelmaker*, October 1989, pp. 91-97.
116. "Calcium Modification of Oxide Inclusions": K. Larsen and R. J. Fruehan, *Trans. ISS, Iron and Steelmaker*, July 1990, p. 45.
117. "Challenges in the Development of New Iron and Steelmaking Processes": R. J. Fruehan, Proceedings of the Annual Meeting of Canadian Chemical Engineering Association, Hamilton Ontario Canada, September 1989.
118. "Potential Benefits of Gas Stirring in An Electric Furnace": R. J. Fruehan, *Trans. ISS, Iron and Steelmaker*, February 1990, pp. 43-50.
119. "Thermodynamics of Nitrogen in Ca-CaF<sub>2</sub> Slags": K. Ito and R. J. Fruehan, *Metall. Trans. B*, Volume 21B, 1990, p. 205.
120. "Fundamental and Long Term Iron and Steelmaking Research in Japan": R. J. Fruehan and A. W. Cramb, "Part I Industry Research", *Iron and Steelmaker*, March 1990, p. 38. "Part II University Research", *Iron and Steelmaker*, April 1990, p. 16.
121. "Thermodynamics of Ti in Ag-Cu Alloys", J. J. Pak, M. L. Santella, and R. J. Fruehan, *Metall. Trans. B*, Volume 21B, April 1990, p. 349.
122. "An Introduction to Vacuum Degassing - Parts I, II, III, IV, V, VI, VII": R. J. Fruehan, *Iron and Steelmaker*, June 1990.
123. "Thermodynamic Behavior of Nitrogen in B<sub>2</sub>O<sub>3</sub> Slag System": D.-J. Min and R. J. Fruehan, *Steelmaking Conference Proceedings*, ISS, 1990, p. 533.
124. "Recent Progress on Ferrous Scrap Treatment": A. W. Cramb and R. J. Fruehan, *TMS-AIME Recycling Conference*, Williamsburg VA, October 1990.
125. "Thermodynamics of Inclusion Formation in Fe-Ti-C-N Alloys": Bahri Ozturk and R. J. Fruehan, *Metall Trans B*, Volume 21B, October 1990, pp. 879.
126. "Discussion of Thermodynamics of Ca-CaF<sub>2</sub> and Ca-CaCl<sub>2</sub> Systems for the Dephosphorization of Steel": C. Nassaralla and R. J. Fruehan, *Metall. Trans. B*, Volume 21B, 1990, p. 1079.
127. "Nitrogen Solution in BaO-B<sub>2</sub>O<sub>3</sub> and CaO-BaO Slags". D.-J. Min and R.J . Fruehan, *Metall. Trans. B*, Volume 21B, 1990, p. 1025.

128. "Iron Bath Smelting - Current Status and Understanding": R. J. Fruehan, SRNC-90, Korean Institute of Metals, 1990, p. 39.
129. "Current Status and Future Developments in Oxygen Steelmaking": R. J. Fruehan, Sixth International Iron and Steel Congress, Nagoya Japan, October 1990, Volume 3, p. 73.
130. "Removal of Nitrogen by BaO-TiO<sub>2</sub> Based Slags": M. Sassagawa, B. Ozturk and R. J. Fruehan, *Trans. ISS*, Iron and Steelmaker, December 1990, p. 51.
131. "Fundamental Study of Slag Foaming in Bath Smelting": R. Jiang and R. J. Fruehan, *Metall Trans B*, Volume 22B, 1991, p. 481.
132. "Analysis of Manganese Smelting in Steelmaking": D.-J. Min and R. J. Fruehan, *Trans. ISS*, I&SM, June 1991, p. 51.
133. "A New Low Temperature Process for Copper Removal from Scrap": A. Cramb and R. J. Fruehan, *Trans ISS*, Iron and Steelmaker, November 1991, p. 61.
134. "Physical Modeling of Slag/Metal Reactions in Combined Blowing": R. Matway, H. Henein and R. J. Fruehan: *Trans ISS*, Iron and Steelmaker, December 1991, p. 43.
135. "Removal of Nitrogen from Steel Using Novel Fluxes": K. Nomura, B. Ozturk and R. J. Fruehan, *Metall Trans B*, Vol. 22B, 1991, p. 787.
136. "The Effect of Na<sub>2</sub>O on Dephosphorization by CaO Based Steelmaking Slags": J. J. Pak and R. J. Fruehan, *Metall Trans B*, Volume 22B, 1991, p. 39.
137. "Thermodynamic Study of Dephosphorization Using BaO-BaF<sub>2</sub>, CaO-CaF<sub>2</sub> and BaO-CaO-CaF<sub>2</sub> System" C. Nassaralla, R. J. Fruehan and D.-J. Min, *Metall Trans B*, Volume 22B, 1991, p. 33.
138. "Modeling of Gas Stirring in Electric Arc Furnaces": X. Zhang and R. J. Fruehan, Proceedings of Electric Furnace Conference, 1991, Volume 49, p. 483.
139. "Slag Foaming in Bath Smelting": R. Jiang and R. J. Fruehan, *Metall Trans B*, Vol. 22B, 1991, p. 481.
140. "Rate of Reduction of FeO in Slag by Fe-C Drops": D.-J. Min and R. J. Fruehan, *Metall Trans B*, Volume 23B, February 1992, p. 29.

141. "Dissolution of Fe<sub>2</sub>O<sub>3</sub> and FeO Pellets in Bath Smelting Flags": Bahri Ozturk and R. J. Fruehan, *ISIJ International*, 1992, Volume 32, pp. 879-884.
142. "Rate of Coal Devolatilization in Iron and Steelmaking Processes. Part I - Experimental Results": R. S. Sampaio, R. J. Fruehan and Bahri Ozturk, *Trans of ISS, I&SM*, August 1992, p. 49.
143. "Rate of Coal Devolatilization in Iron and Steelmaking Processes Part II - Effect of Coal Devolatilization in Energy Efficiency in Bath Smelting": R. S. Sampaio, R. J. Fruehan and Bahri Ozturk, *Trans of ISS, I&SM*, August 1992, p. 59.
144. "Nitrogen Control in Chromium Steels": R. J. Fruehan, INFACON 6, Vol. 2, p. 35, South African Institute of Mining and Metallurgy, Johannesburg, RSA, 1992.
145. "Refining Strategies of Optimization for Phosphorus and Nitrogen Control": R. J. Fruehan, Scaninject VI, Part I, p. 285, MEFOS, Lulea Sweden, 1992.
146. "Reaction Rates and Rate Limiting Factors in Iron Bath Smelting": R. J. Fruehan, Savard/Lee Symposium, TMS, Warrendale PA 1992, p. 233.
147. "Foaming of Ladle and BOS-Mn Smelting Slags": R. E. Roth, R. Jiang and R. J. Fruehan, *Trans ISS, I&SM*, November 1992, p. 55.
148. "Decarburization of Fe-C<sub>sat</sub> Melts by H<sub>2</sub>O at 1523 and 1873 K": R. J. Fruehan, G. R. Belton, F. J. Mannion and Y. Sasaki, *Metall Trans B*, Vol. 23B, 1992, pp. 45-51.
149. "Desulfurization of Bath Smelter Metal": L. B. McFeaters and R. J. Fruehan, *Metall. Trans. B*, Volume 24B, June 1993, pp. 441-447.
150. "Removal of H<sub>2</sub>S from Bath Smelting Gas": B. Ozturk and R. J. Fruehan, *Transactions ISS*, November 1994, pp. 63-67.
151. "Kinetics of Reaction of H<sub>2</sub>O Gas with Liquid Iron": T. Nagasaka and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 25B, April 1994, pp. 245-253.
152. "Reaction Kinetics of H<sub>2</sub>O-CO Gas Mixtures with Liquid Fe-C Alloys": T. Nagasaka and R. J. Fruehan, *ISIJ International*, Voume 34, 1994, No. 3, pp. 241-246.
153. "Physical Model Studies of Slag/Metal Reactions in Gas Stirred Ladles - Determination of Critical Gas Flow Rate": S-H Kim, R. J. Fruehan, R. I. L. Guthrie, *Trans. ISS*, 1993; I&SM, November 1993, p. 71.
154. "Inclusion Formation in Fe-Cr-Ti-N Alloys": B. Ozturk, R. Matway and R. J.

Fruehan, Proceedings of 51st Electric Furnace Conference, ISS,  
November 1993, Washington DC.

155. "Desulfurization of Bath Smelter Metal": L. B. McFeaters and R. J. Fruehan, Proceedings of Steelmaking Conference, ISS, 1993, p. 671.
156. "Kinetics of the Reactions of C<sub>2</sub>H<sub>6</sub>, CH<sub>4</sub>-CO<sub>2</sub> and CO-CO<sub>2</sub>-O<sub>2</sub> Gases with Liquid Iron": Kazuto Sekino, Tetsuya Nagasaka and Richard J. Fruehan, *ISIJ International*, Vol. 40 (2000), No. 4, pp. 315-321.
157. "Metal Decontamination and Recycle Using Liquid Metal Melt-Slag Technology": E. L. Joyce, B. Lally, B. Ozturk and R. J. Fruehan, *International Journal of Environmentally Conscious Design and Manufacturing*, Vol. 2, No. 3, pp. 1-9, 1993.
158. "Manufacturing and Technology Assessment of International Steel Plants": R. J. Fruehan, L. Brinkmeyer, R. Dippenaar, Y. Zhang, *Iron and Steelmaker*, January 1994, pp. 25-31.
159. "Equilibrium Values for the Dissolution of Solid Copper into FeS-Na<sub>2</sub>S Mattes", Y. Zhang, T. Nagasaka, A. W. Cramb and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 25B, April 1994.
160. "Formation of H<sub>2</sub>S in Bath Smelting Process": B. Ozturk, R. Roth and R. J. Fruehan, *ISIJ International*, 1994, vol. 34, pp. 663-699.
161. "Removal of Sulfur from Bath Smelting Gas": B. Ozturk and R. J. Fruehan, *Transactions Iron and Steel Society*, Iron and Steelmaker, November 1994, pp. 63-67.
162. "Effect of Temperature on Slag Foaming": B. Ozturk and R. J. Fruehan, *Metallurgical and Materials Transactions B*, 1994.
163. "Physical Modeling of Bottom-Blown Continuous Steelmaking Part I: The Decarburization Reaction Model and Water Modeling Results": C. A. Abel, R. J. Fruehan and A. Vassilicos, *Transactions of ISS, I&SM*, July 1995, p. 47.
164. "Physical Modeling of Bottom-Blown Continuous Steelmaking Part II: Dimensional Analysis, Process Optimization and Process Feasibility": C. A. Abel, R. J. Fruehan and A. Vassilicos, *Transactions of ISS, I&SM*, Warrendale PA, August 1995, p. 49.
165. "Effect of Gas Types and Pressure on Slag Foaming": Y. Zhang and R. J. Fruehan, Communication in *Metallurgical and Materials Transactions B*, Volume 26B, October 1995, pp. 1088-1092.

166. "Thermodynamics of Inclusion Formation in Fe-Cr-Ti-N Alloys": Bahri Ozturk, R. Matway and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 26B, June 1995, pp. 573-567.
167. "On Hot Metal Desulfurization": E. Oktay and R. J. Fruehan, *Steel Research Journal*, Germany.
168. "Influence of Chromium and Nickel on the Dissociation of CO<sub>2</sub> on Carbon Saturated Liquid Iron", C. P. Petit, R. J. Fruehan, *Metalurgical and Materials Transactions B*, Volume 28B, August 1997, pp. 639-645.
169. "Kinetics of the Reaction of CH<sub>4</sub> with Liquid Iron": K. Sekino, T. Nagasaka and R. J. Fruehan, *Metallurgical and Materials Trans. B*, Volume 26B, April 1995, pp. 317-324.
170. "Modeling of the Two-Zone Smelter - Part 1: Experimental and Fluid Flow Model)": X. Zhang, R. J. Fruehan and A. Vassilicos: Process Technology Conference Proceedings, Vol. 13, 1995, pp. 441-447.
171. "Modeling of the Two-Zone Smelter - Part 2: Physical Modeling and Pilot Plant Trials": X. Zhang, R. J. Fruehan and A. Vassilicos: Process Technology Conference Proceedings, Volume 13, 1995, pp. 445-454.
172. "Effect of Carbonaceous Particles on Slag Foaming": Y. Zhang and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 26B, August 1995, pp. 813-819.
173. "Effect of Bubble Size and Chemical Reactions on Slag Foaming": Y. Zhang and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Vol. 26B, August 1995, pp. 803-812.
174. "Effect of FeO in Slag on the Desulfurization of Hot Metal": P. K. Iwamasa and R. J. Fruehan, Steelmaking Conference Proceedings of ISS, Vol. 78, Nashville TN, April 2-5, 1995, pp. 191-197.
175. "Behavior of DRI and Its Effect on Nitrogen Content in the EAF": D. Goldstein, R. J. Fruehan, B. Ozturk, Electric Furnace Conference Proceedings of ISS, Orlando FL, November 1995.
176. "Applications of Fundamentals to Ladle Processes", R. J. Fruehan, Proceedings of the 14th Process Technology Conference ISS, Orlando FL. November 1995.
177. "Future Steelmaking Technologies and the Role of Basic Research", R. J. Fruehan, *Metall. and Materials Transactions A & B*, 1996.

178. "Fundamentals and Practices for Producing Low Nitrogen Steels", R. J. Fruehan, *ISIJ International*, Volume. 36, 1996, pp. S58-S61.
179. "Vaporization of Zinc from Steel Scrap", Bahri Ozturk and R. J. Fruehan, *ISIJ International* , Volume 36, 1996, pp. S239-S242.
- 180."A Review of Hydrogen Flaking and Its Prevention", R. J. Fruehan, *ISS Transactions of AIME*, August 1997, pp. 61-69.
181. "Separation of Metal Droplets from Slag", P. K. Iwamasa and R. J. Fruehan, *ISIJ International*, Vol. 36, 1996, p. 319. June 1996.
182. "Effect of FeO in the Slag and Silicon in the Metal on the Desulfurization of Hot Metal", P. K. Iwamasa and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 28B, February 1997. pp 47-57.
183. "Thermodynamics of MnO, FeO and Phosphorus in Steelmaking Slags with High MnO Contents", A. T. Morales and R. J. Fruehan, *Metallurgical and Materials Transactions B*, June 1996.
184. "Reduction of FeO in Smelting Slags by Solid Carbon: Experimental Results", B. Sarma, A. W. Cramb and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 27B, October 1996, pp. 717-730.
185. "The Current and Future Competitiveness of the American Steel Industry", R. J Fruehan, The Sloan Steel Industry Study, Pittsburgh PA, November 1996.
186. "Benchmarking of Research in the Specialty Steel Industry", R. J. Fruehan, A. T. Morales, Sloan Steel Industry Study, Pittsburgh PA, December 1996.
187. "Meeting the Challenge: U. S. Industry Faces the 21st Century: The Basic Steel Industry", R. M. Cyert, R. J. Fruehan, J. LaFrance, U.S. Department of Commercial, Office of Technology Policy, December 1996.
188. "Dephosphorization Equilibria Between Liquid Iron and Highly Basic CaO-Based Slags Saturated with MgO", H. Ishii and R. J. Fruehan, *I&SM of ISS*, February 1997, pp. 51-58.
189. "Effect of FeO in the Slag and Silicon in the Metal on the Desulfurization of Hot Metal", P. K. Iwamasa and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 28B, February 1997, pp. 47-57.
190. "Influence of Chromium and Nickel on the Dissociation of CO<sub>2</sub> on Carbon-Saturated Liquid Iron", C.P. Petit and R.J. Fruehan, *Metallurgical and Materials*

*Transactions B*, Vol. 28B, August 1997, pp. 639-645.

191. "Future Steelmaking Technologies and the Role of Basic Research", R. J. Fruehan, *Metallurgical and Materials Transactions A*, Volume 28A, October 1997, pp. 1963-1973.
192. "Slag-Metal Separation in the Blast Furnace Trough", Hagdong Kim, Bahri Ozturk and Richard J. Fruehan, *ISIJ International*, Vol. 38 (1998), No. 5, pp. 430-439.
193. "Kinetics of Phosphorus Vaporization from Slag", Ju-Yeol Ryu, R. J. Fruehan and A. T. Morales, *Transactions of ISS*, January 1999, pp. 59-68.
194. "Reduction of FeO in Smelting Slags by Solid Carbon: Re-examination of the Influence of the Gas-Carbon Reaction", S. R. Story, B. Sarma, R. J. Fruehan, A. W. Cramb and G. R. Belton, *Metallurgical and Materials Transactions B*, Vol. 29B, August 1998, pp. 929-932.
195. "Thermodynamics of  $TiO_x$  in Blast Furnace Type Slags", Y. Morizane, B. Ozturk and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 30B, February 1999, pp. 29-43
196. "The Behavior of Direct Reduced Iron in Slag-Metal Systems and Its Effect on the Nitrogen Content of Steel, Part I: The Behavior of Direct Reduced Iron in Slag Metal Systems", D. A. Goldstein, R. J. Fruehan and B. Ozturk, *Transactions of ISS*, February 1999, p. 4761.
197. "The Behavior of Direct Reduced Iron in Slag-Metal Systems and its Effect on the Nitrogen Content of Steel, Part II: Effect of CO Bubbling and the Use of DRI on the Nitrogen Content of Steel", D. A. Goldstein, R. J. Fruehan and B. Ozturk, *Metallurgical and Materials Transactions B*.
198. "Fundamental Issues in Steel Refining": R. J. Fruehan and A. W. Cramb, Proceedings of Julian Szekely Memorial Symposium on Materials Processing, MIT, Cambridge, MA, October 5-8, 1997.
199. "A Review of Hydrogen Flaking and Its Prevention": R. J. Fruehan, Proceedings of 13th International Forgemasters Meeting, Pusan, Korea, October 12-16, 1997.
200. "Factors Influencing Innovations and Competitiveness in the Steel Industry" R. J. Fruehan, D. Cheij and D. M. Vislosky, Conference proceedings: America's Industrial Resurgence, National Research Council, December 1997.
201. "Modeling Post Combustion in the EAF", S. R. Story and R. J. Fruehan:

Proceedings of the Biennial Materials Conference of The Institute of Materials Engineering, Australia, Wollongong Australia, July 1998, pp. 77-82.

202. "A Critical Review and Evaluation of Alternative Steelmaking Processes", R. J. Fruehan, C. L. Nassaralla, *Transactions of ISS of AIME*, August 1998, pp. 59-68.
203. "A Kinetic Model Demonstrating the Effect of FeO in the Slag and Silicon in the Metal on Hot Metal Desulfurization", P. K. Iwamasa and R. J. Fruehan, Proceedings of Steelmaking Conference, ISS, 1998, p. 383.
204. "A Review of Coal-based Direct Ironmaking Processes", B. Sarma and R. J. Fruehan, Proceedings of ICSTI/Ironmaking Conference, ISS, 1998, p. 1537.
205. "Future Ironmaking in North America", R. J. Fruehan, Proceedings of ICSTI/Ironmaking Conference, ISS, 1998, p. 59.
206. "Evaluation of New Steelmaking Technologies", R. J. Fruehan, C. L. Nassaralla, Proceedings of Steelmaking Conference, ISS, 1998.
207. "Measurement of FeO Activity and Solubility of MgO in Smelting Slags", Shih-Hsien Liu, R. J. Fruehan, A. Morales and B. Ozturk, *Metallurgical and Materials Transactions B*, Vol. 31B, 2000.
208. "Future iron and steelmaking in the USA", R. J. Fruehan, Scandinavian Journal of Metallurgy, Denmark 1999; 28: 77-85.
209. "Kinetics of Phosphorus Vaporization From Slag", J-Y Ryu, R. J. Fruehan and A. T. Morales, *Transactions of ISS of AIME*, January 1999, pp. 59-68.
210. "Kinetics of the Reaction of  $C_2H_6$ ,  $CH_4$ - $CO_2$  and  $CO$ - $CO_2$ - $O_2$  Gases with Liquid Iron", K. Sekino, T. Nagasaka, R. J. Fruehan, *Iron and Steel Institute of Japan*, Vol.40, No. 4, 2000, p. 315.
211. "Kinetics of Oxidation of Carbonaceous Materials by  $CO_2$  and  $H_2O$  between 1300 C and 1500 C", S. R. Story and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Vol. 31B, 2000, p. 43.
212. "Reduction of FeO in Slag with Coal Char", Kwangyong Seo and R. J. Fruehan, *ISIJ International*, Vol. 40, (2000), No. 1, pp. 7-15.
213. "Mathematical Model for Nitrogen Control in Oxygen Steelmaking", D. A. Goldstein and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume

30B, October 1999, p. 945-956.

214. "Modeling of the AISI Two Zone Smelter, Part I – Water Modeling Experiments and the Staged Model Development", X. Zhang, A. Vassilicos and R. J. Fruehan, *Transactions of ISS*, August 1999, p. 51.
215. "Modeling of the AISI, Two Zone Smelter, Part II", X. Zhang, A. Vassilicos and R. J. Fruehan, 13<sup>th</sup> PTD Conference Proceedings of ISS, AIME, 1999, pp. 449-454.
216. "The Effect of Carbon on the Reduction of FeO in Slag", Richard L. Smith and R. J. Fruehan, *Steel Research*, Vol. 70, 1999.
217. "Foaming Characteristics of BOF Slags", SM Jung and R. J. Fruehan, *ISIJ International*, Vol. 40, No. 4, 2000, p. 348.
218. "Status of Direct Reduction and Smelting in the Year 2000", .R. J. Fruehan, J. E. Astier, R. Steffen: Keynote Invited Paper, International Ironmaking Conference, Paris France, June 2000.
219. "The Chemical Diffusivity of Oxygen in Liquid Iron Oxide and Calcium Ferrite Slags", Y Li, J A Lucas, R J Fruehan and G R Belton, *Metallurgical and Materials Transactions B*, Vol. 31B, 2000, p. 1059.
220. "Recent Advances in the Fundamentals and Kinetics of Steelmaking", R. J. Fruehan, D. Goldstein, B. Sarma, S. R. Story, P. C. Glaws and H. W. Pasewicz, Belton Memorial Symposium, Sydney Australia, January 2000, ISS, Warrendale PA, p. 3.
221. "Recent Advances in the Fundamentals and Kinetics of Steelmaking", R. J. Fruehan, D. Goldstein, B. Sarma, S. R. Story, P. C. Glaws and H. W. Pasewicz, Belton Memorial Symposium, Sydney Australia, January 2000, *Metallurgical and Materials Transactions B*, Vol. 31B, 2000, p. 89.
222. "Steel Plant Supplier Relationship", S. D. Sleeper, M. Colon and R. J. Fruehan, Iron and Steel Maker-ISS, March 2000, p. 73.
223. "Waste Oxide Recycling During Oxygen Steelmaking", R. J. Fruehan and C. Molloseau, Iron and Steel Maker-ISS, August 2000, p. 47.
224. "Nitrogen Recovery from Mn Nitrides in Steel Melts", Y. E. Lee and R. J. Fruehan, Materials Science Forum, Vol. 319-320 (1999) pp. 289-296, 1999 Trans Tech Publications, Switzerland.
225. "A Review of Hydrogen Flaking and It's Prevention", R. J. Fruehan, *Transactions*

*of ISS, I&SM*, August 1997, pp. 61-69.

226. "Foamability of Steelmaking Slags in an EAF", J. J. Kerr and R. J. Fruehan, PTD Conference Proceedings of ISS, November 2000, p. 1049.
227. "Behavior of Phosphorus in DRI/HBI During EAF Steelmaking", C. Manning and R. J. Fruehan, PTD Proceedings of ISS, November 2000, p. 1019.
228. "Critical Aspects of Recycling Waste Oxides in Steelmaking", R. J. Fruehan, S. Jung, P. Nogueira and C. Molloseau, Proceedings of Brimacombe Symposium, Vancouver BC Canada, October 2000.
229. "Kinetics of the Reaction of  $C_2H_6$ ,  $CH_4-CO_2$  and  $CO-CO_2-O_2$  Gases with Liquid Iron", Kazuto Sekino, Tetsuya Nagasaka and Richard J. Fruehan, *ISIJ International*, Volume 40, Number 4, 2000, pp. 315-321.
230. "Evaluation of Phosphorus Reaction Equilibrium in Steelmaking", K. Ide and R. J. Fruehan, *Transactions ISS* of AIME, December 2000, p. 65.
231. "Thermodynamics of TiCN and TiC in Fe-C Melts", Y. Li and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Vol. 32B, 2001, pp. 203-205.
232. "Thermodynamics of Titanium Oxide in Slags", S. M. Jung and R. J. Fruehan, *ISIJ International*, Vol. 41, 2001, pp. 1447-1453.
233. "Formation of Titanium Carbonitride from Hot Metal", Yun Li, Youngquan Li and R. J. Fruehan, *ISIJ International*, Vol. 41, 2001, pp. 1417-1422.
234. "Measurement of FeO Activity and Solubility of MgO in Smelting Slags", Shih-Hsien Liu, R. J. Fruehan, A. Morales and B. Ozturk, *Metallurgical and Materials Transactions B*, 2001, Vol. 32B, pp. 31-36.
235. "Modeling of the AISI Two-Zone Smelter, Part II: Physical Modeling and the AISI Pilot Plant Trials", X. Zhang, A. Vassilicos, B. Sarma and R. J. Fruehan, *Transactions of ISS*, June 2001, p. 53.
236. "CFD Simulation of Post-Combustion in the Electric Arc Furnace – Part I: Model Development and Application to Hot Bath", Y. Li and R. J. Fruehan, 59<sup>th</sup> Electric Furnace Conference Proceedings, Phoenix, AZ, 2001, pp. 481-498.
237. "Emerging Technologies for Iron and Steelmaking", C. P. Manning and R. J. Fruehan, *JOM*, 2001, pp. 35-37.

238. "Kinetics of Desulfurization in a Post Smelting Ladle", R. H. Smith and R. J. Fruehan, *Transactions of ISS*, I&SM, April 2002, p. 43.
239. "The Reaction Behavior of Fe-C-S Droplets in CaO-SiO<sub>2</sub>-MgO-SiO<sub>2</sub> Slags", C. L. Molloseau and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Vol. 33, 2002, p. 334.
240. "Foamability of Stainless Steelmaking Slags in an EAF", J. J. Kerr and R. J. Fruehan *Transactions of ISS*, I&SM, November 2002, p. 39.
241. "Blast Furnace Softening and Melting Phenomena – Melting Onset in Acid and Basis Pellets", P. F. Nogueira and R. J. Fruehan, ISS-AIME Ironmaking Conference, 2002, pp. 585-595.
242. "Computation Fluid-Dynamics Simulation of Postcombustion in the Electric Arc Furnace", Yun Li and Richard J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 34B, June 2003, pp. 333-343.
243. "Critical Assessment of Advanced Iron Smelting Process", R. J. Fruehan, *Transactions of ISS*, I&SM, February 2003, pp. 48-61.
244. "Behavior of Phosphorus in Direct Reduced Iron", C. Manning and R. J. Fruehan, submitted to *Transactions of ISS*.
245. "Experimental Evaluation of Slag-Metal Mass Transfer in an EAF", C. Manning and R. J. Fruehan, submitted to *Transactions of ISS*.
246. "Dissolution of Magnesite and Dolomite in Simulated EAF Slags", R. J. Fruehan, Y. Li and L. Brabie, ISSTech 2003 Conference, ISS of AIME, Indianapolis IN, April 2003, pp. 799-812.
247. "Inclusions in Aluminum-Killed Steel with Varying Calcium Additions", K. Ahlborg, R. J. Fruehan, M. S. Potter, S. R. Badger, G. S. Casuccio, ISSTech 2003 Conference, ISS of AIME, Indianapolis IN, April 2003, pp. 177-196.
248. "X-ray observation of Blast Furnace Burden", Paulo F. Nogueira, Richard J. Fruehan, ISSTech Conference, ISS of AIME, Indianapolis IN, April 2003, pp. 153-162.
249. "The Reaction Kinetics of Nitrogen with Liquid Iron Containing Surface Active Species – Is Nitrogen in Steelmaking an Old Subject or a Modern Topic", Tetsuya Nagasaka, Richard J. Fruehan and Alan W. Cramb, ISSTech Conference, ISS of AIME, Indianapolis IN, April 2003, pp. 979-992.

250. "The Use of Fundamentals to Control Dissolved Gases", R. J. Fruehan, ISSTech Conference, ISS of AIME, Indianapolis IN, April 2003, pp. 857-871.
251. "Mechanism and Rate of Reaction of  $\text{Al}_2\text{O}$ , Al and CO Vapors with Carbon", R. J. Fruehan, Y. Li and Gerald Carkin, *Metallurgical and Materials Transactions B*, Volume 35, August 2004, pp. 617-623
252. "Inclusion Analysis to Predict Casting Behavior", S.R. Story, T.J. Piccone, R. J. Fruehan, M. Potter, ISSTech 2003 Conference, ISS of AIME, Indianapolis IN, April 2003, pp. 129-139, Iron and Steel Technology, AIST, September 2004, pp. 163-169.
253. "Blast Furnace Burden Softening and Melting Phenomena-Part I Pellet Bulk Interaction Observation", Paulo Nogueira, Richard Fruehan, *Metallurgical and Materials Transactions B*, Volume 35B, October 2004, pp. 829-838.
254. "Additions to Generate Foam in Stainless Steelmaking", J. J. Kerr and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 35B, August 2004, pp. 643-650.
255. "The Pressure of  $\text{Al}_2\text{O}$  and Al in Equilibrium with a  $\text{Al}_2\text{O}_3\text{-Al}_4\text{C}_3$  (Saturated) Slag at 1950 to 2020,C", R. J. Fruehan and G. Carkin, *Metallurgical and Materials Transactions B*, Volume 35B, October 2004, pp. 1011-1013.
256. "Hydrogen and Nitrogen Control in Ladle and Casting Operations", Siddhartha Misra and Richard J. Fruehan, *Iron and Steelmaking*, April 2004, pp. 34-39.
257. "The Kinetics of the Reaction of  $\text{CO}_2$  with Solid Iron at Elevated Temperatures", L. N. Eastep, R. J. Fruehan, accepted by *Metallurgical and Materials Transactions*.
258. "Fundamental Studies on Blast Furnace Burden Softening and Melting", Paulo F. Nogueira, Richard J. Fruehan, Proceedings of 2<sup>nd</sup> International Meeting on Ironmaking, September 2004, Vitoria, Brazil.
259. "Blast Furnace Softening and Melting Phenomena - Part III: Melt Onset and Initial Microstructural Transformation in Pellets", Paulo F. Nogueira, Richard J. Fruehan, submitted to *Materials and Metallurgical Transactions B*.
260. "Evaluation of a New Process for Ironmaking: a Productivity Model for the Rotary Hearth Furnace: Otavio Fortini and Richard Fruehan, *Steel Research Int.*, 75 (2004), No. 10, pp. 625-631.
261. "Research on Sustainable Steelmaking", R. J. Fruehan, AISTech 2004 Proceedings, (2004) Vol. 1, pp. 3-19.

262. "Rate of Reduction of Ore-Carbon Composites Part I: Determination of Intrinsic Rate Constants", O.M. Fortini and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 36B, December 2005, pp. 709-717.
263. "Unique Functions of Slags in Steelmaking", R. J. Fruehan, Proceedings of VII International Conference on Molten Slags, Fluxes and Salts, Cape Town, SA, January 2004.
264. "Future of Oxygen Steelmaking: Myths and Reality", R. J. Fruehan, Oxygen Steelmaking Conference, The Conference of Metallurgists, Ontario Canada, August 2004.
265. "Phosphorus Equilibrium Between Hot Metal and Slag", C. M. Lee and R. J. Fruehan, Institute of Materials, Minerals and Mining, *Ironmaking and Steelmaking*, 2005, Volume 32, No. 6, pp. 503-508.
266. "Final Stage of Reduction of Iron Ores by Hydrogen", R. J. Fruehan, Y. Li, L. Brabie, E-J Kim, *Scandinavian Journal of Metallurgy*, June 2005, Volume 34, 3, pp. 205-212.
267. "New steelmaking processes: drivers, requirements and potential impact", R. J. Fruehan, *Ironmaking and Steelmaking*, Institute of Materials, Minerals and Mining, London UK, 2005, Vol. 32, No. 1, pp. 3-8.
268. "Rate of Reduction of Ore-Carbon Composites Part II: Modeling of Reduction in Extended Composites", O. M. Fortini and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 36B, December 2005, pp. 865-872.
269. "Activity of Titanium in Fe-Cr Melts", H. Y. Choi, W. E. Slye and R. J. Fruehan, *Metallurgical and Materials Trans. B* (communications), Volume 36B, 2005, pp. 537-541.
270. "Hydrogen and Nitrogen Pickup from Ladle Additions", Siddhartha Misra, R. P. Stone, M. Kan and R. J. Fruehan, submitted to *Metallurgical and Materials Trans. B*.
271. "Contributions by Japanese Researchers at Carnegie Mellon University", R. J. Fruehan, *ISIJ International*, Volume 45, No. 9, September 2005.
272. "Application of Rapid Inclusion Identification and Analysis", Scott R. Story, Samuel M. Smith, Richard J. Fruehan, Gary S. Casuccio, Michael S. Potter and Traci Lersch, AISTech 2004, The Iron & Steel Technology Conference and Exposition, Nashville Tenn, September 2005, pp. 41-49.

273. "Blast Furnace Burden Softening and Melting Phenomena-Part II Evolution of the Structure of the Pellets", Paulo F. Nogueira, Richard J. Fruehan, *Metallurgical and Materials Transactions*, Volume 36B, October 2005, pp. 583-590
274. "Reduction of Iron Oxides by Volatiles in a Rotary Hearth Furnace Process: Part I. The Role and Kinetics of Volatile Reduction", I. Sohn and R. J. Fruehan, *Metallurgical and Materials Transactions B*, Volume 36B, October 2005, pp. 605-612.
275. "The Reduction of Iron Oxides by Volatiles in a Rotary Hearth Furnace Process: Part II. The Reduction of Iron Oxide/Carbon Composites", I. Sohn and R. J. Fruehan, accepted by *Metallurgical and Materials Transactions B*, 2006.
276. "Behavior of DRI and HBI in upper blast furnace shaft: Part I - Fundamentals of Kinetics and Mechanism of Oxidation", P. Kaushik and R. J. Fruehan, submitted to *Metallurgical and Materials Transactions B*.
277. "Behavior of DRI and HBI in upper blast furnace shaft: Part II – A Model of Oxidation", P. Kaushik and R. J. Fruehan, submitted to *Metallurgical and Materials Transactions B*.
278. "Mixed Burden Softening and Melting Phenomena in Blast Furnace Operation: Part I – X-ray Observation of Ferrous Burden", P. Kaushik and R. J. Fruehan, submitted to *Ironmaking and Steelmaking*.
279. "Mixed Burden Softening and Melting Phenomena in Blast Furnace Operation: Part II – Mechanism of Softening and Impact on Cohesive Zone": P. Kaushik and R. J. Fruehan, submitted to *Ironmaking and Steelmaking*.
280. "Study of Casting Issues using Rapid Inclusion Identification and Analysis", Scott R. Story, Gerry E. Goldsmith, Richard J. Fruehan, Gary S. Casuccio, Michael S. Potter and David M. Williams, AISTech 2006 conference, AIST

## **Books**

R. J. Fruehan: "Ladle Metallurgy Principles and Practices", Iron and Steel Society, Warrendale, PA., 1985.

R. J. Fruehan: "Vacuum Degassing of Steel", Iron and Steel Society, Warrendale, PA, 1990.

R. Ahlbrandt, R. J. Fruehan, F.Giarratani: "The Renaissance of American steel: Lessons for managers in competitive industries", Oxford Press, NY. 1996

S. K. Smith, R. R. Albright, R. J. Fruehan: "Major Trends in Global Steel Industry Technology and Their Implications for Human Resources Management and Industrial Relations", Chapter in book "Strengthening Steel: Changing Workplace and Employment Relations in the Global Content", Anil Verma (ed.).

Richard J. Fruehan: "Iron smelting and steelmaking reactions" chapter in book "Advanced Physical Chemistry for Process Metallurgy", N. Sano, W-K Lu, R. V. Riboud, M. Maeda, editors, Academic Press, London, UK, 1997.

R. J. Fruehan, Editor: "Steelmaking and Refining Volume "Making Shaping and Treating of Steel", AISE Foundation, Pittsburgh PA, 1998.

R. J. Fruehan: Chapter: "Overview of Steelmaking Processes and Their Development"; Chapter: "Fundamentals of Iron and Steelmaking"; Chapter: Alternative Oxygen Steelmaking Processes" in book "The Making, Shaping and Treating of Steel", Richard J. Fruehan, editor, AISE Foundation, Pittsburgh PA, 1998.

R. J. Fruehan: Chapter: "Reduction Smelting Processes - Technology and Economics" in book "Direct Reduced Iron", Jerome Feinman and Donald R. MacRae, editors, Iron and Steel Society, Warrendale PA, 1999.

R. J. Fruehan, Chapter, "Fundamentals of Iron and Steelmaking, Ironmaking Volume", "Making Shaping and Treating of Steel", AISE Foundation, Pittsburgh PA, 2000.