Supplementary Materials for

EFFECT OF ADDING BIOMASS FROM PALM KERNEL SHELL ON PHASE TRANSFORMATION AND MICROSTRUCTURE DURING CARBOTHERMIC REDUCTION OF ILMENITE

Cynta Immanuela Lamandasa¹, Agung Setiawan¹, Sri Harjanto^{1*}, M. Akbar Rhamdhani²

¹ *Department of Metallurgical and Materials, Faculty of Engineering, Universitas Indonesia, Depok 16424, Indonesia*

² *Fluid and Process Dynamics (FPD) Research Group, Department of Mechanical and Product Design Engineering, Swinburne University of Technology, Melbourne, VIC 3122, Australia.*

***Corresponding author:**

Sri Harjanto

E-mail: (sri.harjanto@ui.ac.id)

Table S1 Chemical composition of ilmenite ore concentrate (wt.%)

TiO₂	Fe₂O₃	SiO₂	Al₂O₃	CaO	CoO	Cr₂O₃	K₂O	MgO	Mn₃O₄
50.2	37.05	0.39	2.06	0.046	0.013	4.245	<DL*	1.54	1.505
Na₂O	Nb₂O₅	NiO	P₂O₅	PbO	Sc₂O₃	SO₃	V₂O₅	ZrO₂	Total
0.035	0.157	0.011	0.16	0.051	0.017	0.023	0.231	0.245	97.8

*<DL: less than the detection limit

Table S2 The calorific, proximate, and ultimate analysis of palm kernel shell biomass (wt.%)

Proximate				Ultimate					Calorific Value (cal/g)
Fixed Carbon	Volatile Matter	Moisture	Ash	C	S	H	O	N	
79.22	11.12	6.06	3.60	80.59	0.08	3.05	11.89	0.79	7.095

Figure S1 Particle size distribution of (a) ilmenite ore concentrate and (b) pulverized biomass.

Figure S2 Microstructure of the reduced samples with addition of 9 wt% biomass reacted at different temperatures: (a) 1000°C; (b) 1100°C; and (c) 1200°C, for 2 hours.

Figure S3 Microstructure of the reduced samples with addition of 9 wt% at 1200°C for: (a) 0.5 h; (b) 1 h; (c) 2 h; and (d) 3 h