Supplementary Information

Percolation of a liquid metal binder in energy generating composites

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Particle Size Distributions

Table S1 Particle size distribution for indium from particle size analyzer.

Size	Count	Cumulative	Size	Count	Cumulative	Size	Count	Cumulative
0.514	7	7	2.38	8682	126878	10.548	431	204201
0.542	6	13	2.457	7961	134839	11.133	309	204510
0.57	7	20	2.593	6126	140965	11.75	249	204759
0.604	7	27	2.737	6937	147902	12.402	168	204927
0.67	13	40	2.889	5465	153367	13.09	164	205091
0.673	11	51	3.049	4746	158113	13.816	104	205195
0.71	14	65	3.218	4813	162926	14.582	120	205315
0.749	13	78	3.396	4222	167148	15.39	80	205395
0.791	17	95	3.585	3404	170552	12.244	62	205457
0.835	24	119	3.783	3812	174364	17.145	42	205499
0.881	23	142	3.993	3651	178015	18.095	40	205539
0.93	27	169	4.215	2634	180649	19.099	36	205575
0.982	32	201	4.448	3043	183692	20.158	32	205607
1.036	33	234	4.695	2307	185999	21.275	19	205626
1.093	48	282	4.955	2278	188277	22.455	11	205637
1.154	55	337	5.23	2324	190601	23.7	12	205649
1.218	94	431	5.52	1707	192308	25.014	9	205658
1.286	268	699	5.826	1882	194190	26.401	3	205661
1.357	1221	1920	6.149	1422	195612	27.865	6	205667
1.432	7303	9223	6.49	1572	197184	29.401	2	205669
1.512	18113	27336	9.85	1155	198339	32.762	4	205673
1.595	16758	44094	7.23	1181	199520	36.497	1	205674
1.684	15429	59523	7.631	1066	200586	40.656	1	205675
1.777	15043	74566	8.054	756	201342	42.911	1	205676
1.876	12417	86983	8.5	814	202156	45.29	3	205679
1.98	12368	99351	8.972	648	202804	47.801	1	205680
2.09	9900	109251	9.469	521	203325	56.202	2	205682
2.205	8945	118196	9.994	445	203770	133.276	1	205683

Table S2 Particle size distribution for manganese dioxide from particle size analyzer.

Size	Count	Cumulative	Size	Count	Cumulative	Size	Count	Cumulative
0.514	42	42	2.737	22535	247369	14.582	91	674564
0.542	41	83	2.889	20450	267819	15.39	56	674620
0.52	76	159	3.049	20179	287998	16.244	32	674652
0.604	73	232	3.218	21561	309559	17.145	19	674671
0.637	118	350	3.396	20541	330100	18.095	21	674692
0.673	100	450	3.585	18493	348593	19.099	14	674706
0.71	144	594	3.783	22860	371453	21.158	13	674719
0.749	181	775	3.993	23200	394653	21.275	19	674738
0.791	170	945	4.215	19048	413701	22.455	21	674759
0.835	195	1140	4.448	23449	437150	23.7	14	674773
0.881	195	1335	4.695	20042	457192	25.014	15	674788
0.93	220	1555	4.955	19761	476953	26.401	8	674796
0.98	298	1853	5.23	23657	500610	27.865	3	674799
1.036	339	2192	5.52	18704	519314	29.41	13	674812
1.093	420	2612	5.826	22471	541785	31.041	9	674821
1.154	635	3247	6.149	17984	559769	34.579	3	674824
1.18	804	4051	6.49	20359	580128	36.497	3	674827
1.286	1753	5804	6.85	15540	595668	38.52	4	674831
1.35	3323	9127	7.23	16596	612264	40.656	2	674833
1.432	7783	16910	7.631	14731	626995	42.911	3	674836
1.512	14460	31370	8.054	10791	637786	45.29	2	674838
1.595	15889	47259	8.5	10422	648208	47.801	1	674839
1.684	17373	64632	8.972	8118	656326	50.452	2	674841
1.777	19785	84417	9.49	6160	662486	53.249	1	674842
1.876	18579	102996	9.994	4331	666817	56.202	2	674844
1.98	21197	124193	10.548	3449	670266	62.607	1	674845
2.09	19340	143533	11.133	1841	672107	69.743	1	674846
2.205	19669	163202	11.75	1233	673340	86.547	1	674847
2.382	21268	184470	12.402	569	673909	113.354	1	674848
2.457	21670	206140	13.09	378	674287	133.276	1	674849
2.593	18694	224834	13.816	186	674473			

Table S3 Particle size distribution of magnesium from particle size analyzer.

Size	Count	Cumulative	Size	Count	Cumulative	Size	Count	Cumulative
0.514	3	3	3.049	4685	67417	18.095	4675	307005
0.542	4	7	3.218	5055	72472	19.099	4285	311290
0.572	3	10	3.396	5184	77656	20.158	4229	315519
0.604	4	14	3.585	4710	82366	21.275	3290	318809
0.637	3	17	3.783	6004	88370	22.455	3348	322157
0.673	4	21	3.993	6524	94894	23.7	2982	325139
0.71	4	25	4.215	5512	100406	25.014	2369	327508
0.749	8	33	4.448	6851	107257	26.401	1747	329255
0.791	6	39	4.695	6100	113357	27.865	1696	330951
0.835	4	43	4.955	6293	119650	29.41	1494	332445
0.881	12	55	5.23	7852	127502	31.041	1145	333590
0.93	16	71	5.52	6627	134129	32.762	896	334486
0.982	16	87	5.826	8393	142522	34.579	675	335161
1.036	16	103	6.149	7355	149877	36.497	566	335727
1.093	26	129	6.49	8802	158679	38.52	485	336212
1.154	34	163	6.85	7562	166241	40.565	348	336560
1.218	64	227	7.23	8938	175179	42.911	244	336804
1.286	138	365	7.631	9216	184395	45.29	169	336973
1.357	491	856	8.054	7738	192133	47.801	138	337111
1.432	2066	2922	8.5	9264	201397	50.452	89	337200
1.512	4542	7464	8.972	9159	210556	53.249	49	337249
1.595	4519	11983	9.469	9072	219628	56.202	41	337290
1.684	4621	16604	9.994	8834	228462	59.318	26	337316
1.777	4914	21518	10.54	10097	238559	62.607	21	337337
1.876	4395	25913	11.133	7991	246550	66.079	14	337351
1.98	4865	30778	11.751	8944	255494	69.743	5	337356
2.09	4207	34985	12.402	7439	262933	73.61	7	337363
2.205	4381	39366	13.09	8094	271027	77.692	5	337368
2.328	4695	44061	13.816	7301	278328	82	5	337373
2.457	4830	48891	14.582	6928	285256	86.547	2	337375
2.593	4040	52931	15.39	6186	291442	91.346	1	337376
2.737	5186	58117	16.24	5725	297167	96.411	1	337377
2.889	4615	62732	17.145	5163	302330			

Theoretical Maximum Density Calculations

The theoretical maximum densities of the thin sheets and LFA pellets were calculated using Eq. (1), given the masses (M) and densities (ρ) of Mg, MnO_2 and In used in each sample. The mass of In was varied experimentally, and the masses of Mg and MnO_2 were balanced stoichiometrically per Reaction (1).

$$TMD = \frac{M_{Mg}\rho_{Mg} + M_{MnO_2}\rho_{MnO_2} + M_{In}\rho_{In}}{M_{Mg} + M_{MnO_2} + M_{In}} \quad (1)$$

The percent TMD was calculated for each pressed LFA pellet and pressed thin sheet using the mass and volume (V) of each pellet after pressing. This calculation is shown in Eq. (2).

$$\%\,TMD = \frac{M_{sample}/V_{sample}}{TMD} \quad (2)$$

The custom thin sheet press produced samples 0.635cm wide and 6.985cm in total length, with a full radius on each end. The press was shimmed to a height of 0.889cm, resulting in samples with a volume of 0.387cm^3. The calculated TMDs, sample masses, resultant densities and %TMDs for the pressed thin sheets used in this study are shown in Table S4. In general, the theoretical maximum density was 70%. As porosity is the compliment of the theoretical maximum density, this corresponds to a porosity of 30% for each of the samples generated in this study.

Table S4. Theoretical maximum density calculations for the thin sheets used to measure flame speeds. In general, the theoretical maximum density was ~70%.

In wt. %	TMD	In vol.% (TMD)	In vol.% (70% TMD)	Mass (g)	Density (g/cm^3)	% TMD
20	4.54	9%	**6%**	1.2150	3.14	69%
				1.2115	3.13	69%
30	4.89	15%	**10%**	1.3298	3.44	70%
				1.3297	3.44	70%
40	5.23	21%	**14%**	1.4486	3.75	72%
				1.4820	3.83	73%
50	5.58	29%	**19%**	1.5117	3.91	70%
				1.5323	3.96	71%
60	5.93	38%	**27%**	1.6230	4.20	71%

		1.6124	4.17	70%

The die used to press pellets for the LFA was 12.5mm in diameter and shimmed to 1.7mm, resulting in pellets with a volume of 0.212cm^3. The TMDs, masses, densities and %TMDs for the pressed thin sheets used in this study are shown in Table S5.

Table S5. Theoretical maximum density calculations for the pellets used in the LFA. In general, the theoretical maximum density was slightly less than 70%

In wt. %	TMD	In vol.% (TMD)	In vol.% (70% TMD)	Mass (g)	Density (g/cm^3)	% TMD
0	3.85	0%	**0%**	0.5146	2.43	63%
				0.5287	2.49	65%
				0.5263	2.48	65%
20	4.54	9%	**6%**	0.6429	3.03	67%
				0.6268	2.96	65%
				0.6475	3.05	67%
30	4.89	15%	**10%**	0.6992	3.30	68%
				0.6993	3.30	68%
				0.6907	3.26	67%
40	5.23	21%	**14%**	0.7393	3.49	67%
				0.7452	3.52	67%
50	5.58	29%	**19%**	0.7946	3.75	67%
				0.7934	3.74	67%
				0.7777	3.67	66%