

LAMPIRAN 1

DATA HASIL PENGUJIAN ARUS DAN TEGANGAN

Iluminasi (lux)	Percobaan ke 1									
	P 3 C 1		P 1 C 1		P 1 C 3		P		C	
	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)
30	1,1	1	3,2	1,5	0,5	0,1	0,2	1,1	0	0
2500	32,8	1,7	14,1	3,9	6,6	0,2	15,9	2,9	9	0,8
2700	33,2	1,9	15,9	4,5	7,6	0,2	16,8	3,1	9,2	0,9
2800	34,3	1,9	17,9	4,5	7,9	0,2	17,1	3,1	9,9	0,9
2900	35	1,9	19,8	4,6	8,1	0,2	17,2	3,1	10,1	0,9
3100	35,2	1,9	19,9	4,8	8,3	0,2	17,4	3,1	10,8	0,9
3700	35,8	2	20,7	5,4	9,2	0,2	18,2	3,1	11,2	0,9
3900	36,1	2	20,7	5,6	9,5	0,2	18,4	3,1	11,3	0,9
4700	36,9	2,1	20,5	6,5	10,7	0,3	19,6	3,3	11,7	1
4800	37	2,1	20,5	6,7	10,9	0,3	19,5	3,3	11,8	1
5000	37	2,1	20,7	6,8	11	0,3	19,7	3,4	11,5	1

Iluminasi (lux)	Percobaan ke 2									
	P 3 C 1		P 1 C 1		P 1 C 3		P		C	
	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)
30	6,3	0	0,1	0	2,9	0	20,8	1	1	0,1
2500	24,4	0,6	8,2	0,6	4,6	0,3	60,8	2,1	11	1,6
2700	27,3	0,7	9,3	0,7	5,7	0,4	64	2,3	12,5	1,9
2800	28,2	0,8	9,7	0,7	6,7	0,4	65,9	2,4	13,4	2
2900	30	0,8	9,9	0,7	7,1	0,4	66,5	2,9	14,2	2
3100	30,5	0,8	10,2	0,7	7,5	0,4	65	3,1	15,1	1,9
3700	31,3	0,9	10,6	0,7	9,1	0,4	69,3	3,6	17	2
3900	31,6	0,9	11,1	0,7	9,3	0,4	69,2	3,7	17,8	1,9
4700	32,6	0,9	11,4	0,7	11,5	0,5	68,1	4,4	18,9	1,9
4800	32,7	0,9	11,5	0,7	11,8	0,5	68,1	4,4	19,1	1,9
5000	32,9	0,9	11,5	0,7	11,9	0,5	69,5	4,4	19,4	1,9

Iluminasi (lux)	Percobaan 3									
	P 3 C 1		P 1 C 1		P 1 C 3		P		C	
	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)
30	5,2	0,1	7,6	1,9	5,6	0,3	22,2	1,6	16,7	0,1
2500	30,1	1,4	13,4	2,7	7,6	0,6	53	5,1	20,8	0,2
2700	31,8	1,6	14,2	2,5	7,9	0,6	54,3	5,5	21,5	0,2
2800	31,7	1,6	13,9	2,5	8,1	0,6	55,3	5,7	21,8	0,3
2900	32	1,7	14	2,3	8,4	0,6	55,7	5,8	21,5	0,3
3100	32,6	1,7	14,2	2,3	8,6	0,6	56,1	6	21,6	0,3

3700	33,1	2	15	2,3	9,5	0,7	57	7,1	22,9	0,3
3900	33,1	2,1	15,4	2,3	9,8	0,7	57,8	7,4	23,2	0,3
4700	32,1	2,4	14,6	2,3	10,6	0,7	58,5	8,6	24,8	0,3
4800	32,5	2,5	14,6	2,3	10,8	0,8	57,4	8,8	24,9	0,3
5000	32,8	2,5	14,8	2,3	11	0,8	57,4	9,1	25	0,4

Iluminasi (lux)	Percobaan 4									
	P 3 C 1		P 1 C 1		P 1 C 3		P		C	
	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)	V (mV)	I (μ A)
30	13,3	0,1	8,4	0	12,9	0,1	14,6	0,2	7,2	0,2
2500	34,8	0,7	14,1	0,1	14,9	0,8	42,1	0,3	11,8	0,3
2700	36,7	0,8	15,6	0,2	16,3	0,9	46	0,3	13,4	0,4
2800	37,8	0,9	16,3	0,2	16,8	0,9	47,2	0,3	13,8	0,4
2900	37,4	1	16,4	0,2	17,6	0,9	48,4	0,3	14,4	0,4
3100	37,2	1,2	17	0,2	18,6	0,8	48	0,4	16	0,4
3700	37,8	1,4	18,2	0,2	18,6	0,7	46,9	0,4	17,5	0,4
3900	37,9	1,4	18,6	0,2	18,7	0,7	47	0,4	18	0,4
4700	38,9	1,2	20,2	0,2	19,1	0,7	47,3	0,4	19,7	0,4
4800	38,9	1,3	20,2	0,2	18,8	0,7	47,4	0,4	19,8	0,4
5000	39,2	1,3	20,4	0,2	19	0,7	46,4	0,4	19,8	0,4

LAMPIRAN 2

DATA HASIL PENGUJIAN ABSORBANSI *DYE*

Panjang gelombang (nm)	Absorbansi Sampel <i>Phycocyanin</i> (a.u)	Absorbansi Sampel <i>Carotene</i> (a.u)	Absorbansi Sampel 3 <i>Carotene</i> : 1 <i>Phycocyanin</i> (a.u)	Absorbansi Sampel 1 <i>Carotene</i> : 1 <i>Phycocyanin</i> (a.u)	Absorbansi Sampel 1 <i>Carotene</i> : 3 <i>Phycocyanin</i> (a.u)
400	1,998	1,372	1,704	2,009	1,842
401	1,989	1,39	1,73	2,002	1,831
402	1,982	1,409	1,748	1,989	1,819
403	1,965	1,426	1,771	1,98	1,812
404	1,958	1,447	1,796	1,976	1,804
405	1,946	1,47	1,824	1,968	1,796
406	1,94	1,496	1,85	1,955	1,789
407	1,929	1,524	1,885	1,95	1,779
408	1,92	1,559	1,927	1,939	1,769
409	1,909	1,595	1,971	1,933	1,762
410	1,894	1,637	2,018	1,919	1,752
411	1,886	1,684	2,071	1,911	1,74
412	1,871	1,733	2,122	1,891	1,73
413	1,854	1,786	2,187	1,881	1,717
414	1,837	1,841	2,235	1,867	1,701
415	1,817	1,896	2,301	1,85	1,684
416	1,795	1,939	2,341	1,827	1,667
417	1,766	1,988	2,391	1,804	1,644
418	1,739	2,04	2,435	1,779	1,623
419	1,709	2,09	2,468	1,754	1,6
420	1,673	2,124	2,497	1,726	1,579
421	1,639	2,157	2,529	1,698	1,554
422	1,606	2,189	2,526	1,667	1,53
423	1,571	2,204	2,55	1,637	1,505
424	1,536	2,219	2,545	1,608	1,48
425	1,499	2,222	2,548	1,576	1,454
426	1,463	2,225	2,531	1,545	1,429
427	1,429	2,223	2,529	1,515	1,403
428	1,393	2,226	2,519	1,485	1,378
429	1,359	2,226	2,51	1,456	1,353
430	1,327	2,229	2,497	1,428	1,331
431	1,296	2,242	2,499	1,402	1,308
432	1,265	2,263	2,507	1,375	1,285
433	1,236	2,284	2,513	1,351	1,264
434	1,207	2,317	2,517	1,326	1,244
435	1,178	2,364	2,523	1,301	1,222
436	1,151	2,411	2,54	1,278	1,203

437	1,123	2,462	2,558	1,255	1,183
438	1,098	2,524	2,558	1,232	1,165
439	1,073	2,583	2,574	1,211	1,146
440	1,047	2,64	2,579	1,188	1,128
441	1,022	2,699	2,579	1,168	1,11
442	0,998	2,74	2,571	1,148	1,093
443	0,972	2,789	2,568	1,126	1,075
444	0,948	2,828	2,562	1,106	1,057
445	0,925	2,864	2,541	1,085	1,04
446	0,902	2,873	2,543	1,067	1,025
447	0,88	2,866	2,519	1,047	1,008
448	0,858	2,867	2,507	1,029	0,993
449	0,838	2,882	2,488	1,012	0,978
450	0,818	2,849	2,47	0,995	0,964
451	0,799	2,816	2,451	0,979	0,949
452	0,782	2,782	2,438	0,964	0,936
453	0,765	2,74	2,423	0,949	0,924
454	0,75	2,694	2,404	0,935	0,912
455	0,736	2,641	2,382	0,923	0,9
456	0,723	2,584	2,362	0,912	0,89
457	0,711	2,535	2,347	0,9	0,881
458	0,698	2,482	2,327	0,89	0,871
459	0,687	2,432	2,31	0,879	0,861
460	0,677	2,396	2,292	0,87	0,853
461	0,667	2,359	2,277	0,86	0,844
462	0,658	2,334	2,257	0,851	0,836
463	0,649	2,321	2,246	0,843	0,829
464	0,64	2,314	2,239	0,835	0,822
465	0,633	2,315	2,236	0,828	0,816
466	0,625	2,333	2,235	0,821	0,81
467	0,618	2,35	2,235	0,815	0,804
468	0,612	2,376	2,24	0,809	0,799
469	0,606	2,412	2,241	0,804	0,795
470	0,6	2,443	2,25	0,799	0,79
471	0,595	2,473	2,251	0,794	0,786
472	0,59	2,495	2,251	0,791	0,783
473	0,586	2,518	2,255	0,787	0,779
474	0,582	2,531	2,254	0,783	0,776
475	0,578	2,53	2,249	0,78	0,774
476	0,574	2,523	2,248	0,777	0,771
477	0,571	2,497	2,24	0,774	0,768
478	0,568	2,469	2,232	0,771	0,765
479	0,565	2,431	2,216	0,768	0,763

480	0,563	2,377	2,204	0,766	0,761
481	0,56	2,319	2,189	0,763	0,758
482	0,558	2,247	2,165	0,761	0,756
483	0,557	2,168	2,132	0,759	0,753
484	0,555	2,078	2,096	0,757	0,751
485	0,554	1,984	2,053	0,755	0,748
486	0,553	1,887	1,997	0,753	0,746
487	0,552	1,787	1,934	0,751	0,744
488	0,551	1,683	1,857	0,75	0,742
489	0,551	1,576	1,775	0,748	0,74
490	0,551	1,476	1,687	0,747	0,738
491	0,552	1,37	1,592	0,745	0,736
492	0,552	1,269	1,495	0,744	0,734
493	0,553	1,174	1,399	0,743	0,733
494	0,554	1,08	1,3	0,742	0,732
495	0,556	0,994	1,208	0,741	0,73
496	0,557	0,909	1,116	0,74	0,729
497	0,559	0,829	1,029	0,739	0,729
498	0,562	0,758	0,95	0,737	0,728
499	0,564	0,693	0,877	0,736	0,728
500	0,567	0,632	0,806	0,733	0,728
501	0,57	0,578	0,742	0,731	0,729
502	0,573	0,527	0,683	0,728	0,729
503	0,576	0,481	0,631	0,724	0,73
504	0,58	0,441	0,584	0,723	0,731
505	0,584	0,407	0,545	0,718	0,732
506	0,588	0,375	0,507	0,715	0,733
507	0,593	0,346	0,475	0,712	0,735
508	0,598	0,321	0,446	0,709	0,737
509	0,603	0,3	0,42	0,706	0,739
510	0,608	0,28	0,396	0,704	0,742
511	0,614	0,263	0,375	0,702	0,745
512	0,62	0,248	0,358	0,7	0,748
513	0,627	0,235	0,343	0,699	0,751
514	0,634	0,223	0,33	0,699	0,755
515	0,641	0,214	0,318	0,699	0,759
516	0,649	0,205	0,308	0,7	0,764
517	0,657	0,198	0,299	0,702	0,769
518	0,666	0,191	0,291	0,704	0,774
519	0,675	0,185	0,285	0,707	0,78
520	0,685	0,18	0,279	0,71	0,786
521	0,695	0,176	0,274	0,714	0,792
522	0,705	0,172	0,27	0,718	0,798

523	0,716	0,169	0,266	0,722	0,805
524	0,727	0,166	0,263	0,727	0,812
525	0,738	0,163	0,26	0,732	0,819
526	0,75	0,161	0,257	0,738	0,827
527	0,762	0,158	0,255	0,743	0,835
528	0,774	0,157	0,253	0,75	0,843
529	0,787	0,155	0,251	0,757	0,851
530	0,801	0,153	0,249	0,764	0,861
531	0,815	0,152	0,247	0,771	0,87
532	0,83	0,15	0,247	0,778	0,879
533	0,845	0,149	0,245	0,787	0,89
534	0,862	0,147	0,244	0,795	0,901
535	0,879	0,146	0,242	0,803	0,912
536	0,896	0,144	0,241	0,812	0,923
537	0,913	0,143	0,241	0,822	0,934
538	0,932	0,142	0,239	0,83	0,947
539	0,951	0,141	0,238	0,839	0,959
540	0,971	0,139	0,236	0,847	0,973
541	0,991	0,138	0,235	0,856	0,986
542	1,012	0,137	0,233	0,865	1
543	1,034	0,136	0,232	0,874	1,014
544	1,055	0,135	0,231	0,883	1,029
545	1,078	0,134	0,23	0,893	1,044
546	1,1	0,133	0,23	0,903	1,059
547	1,124	0,132	0,228	0,913	1,075
548	1,147	0,132	0,228	0,922	1,091
549	1,171	0,131	0,227	0,932	1,107
550	1,197	0,13	0,226	0,942	1,124
551	1,222	0,129	0,225	0,952	1,141
552	1,248	0,129	0,225	0,961	1,158
553	1,273	0,128	0,224	0,97	1,175
554	1,299	0,127	0,224	0,979	1,193
555	1,325	0,127	0,223	0,988	1,211
556	1,351	0,126	0,222	0,997	1,229
557	1,378	0,125	0,222	1,005	1,247
558	1,406	0,125	0,222	1,013	1,266
559	1,436	0,124	0,221	1,022	1,286
560	1,466	0,123	0,221	1,031	1,306
561	1,495	0,123	0,22	1,039	1,327
562	1,526	0,122	0,219	1,048	1,349
563	1,557	0,121	0,219	1,056	1,37
564	1,589	0,12	0,218	1,064	1,393
565	1,621	0,12	0,218	1,073	1,414

566	1,654	0,119	0,217	1,08	1,436
567	1,688	0,119	0,217	1,086	1,458
568	1,72	0,118	0,217	1,092	1,48
569	1,754	0,117	0,216	1,098	1,503
570	1,783	0,117	0,215	1,103	1,523
571	1,815	0,116	0,215	1,108	1,545
572	1,844	0,116	0,215	1,112	1,566
573	1,874	0,115	0,214	1,116	1,586
574	1,904	0,115	0,214	1,117	1,607
575	1,934	0,114	0,213	1,122	1,627
576	1,962	0,114	0,213	1,118	1,646
577	1,989	0,114	0,213	1,137	1,665
578	2,016	0,113	0,212	1,143	1,685
579	2,043	0,113	0,212	1,145	1,704
580	2,07	0,112	0,212	1,147	1,723
581	2,098	0,112	0,211	1,151	1,742
582	2,126	0,111	0,21	1,154	1,761
583	2,154	0,111	0,209	1,156	1,782
584	2,183	0,11	0,208	1,157	1,801
585	2,211	0,11	0,208	1,161	1,821
586	2,239	0,109	0,208	1,155	1,841
587	2,264	0,109	0,208	1,155	1,862
588	2,293	0,108	0,207	1,151	1,882
589	2,32	0,108	0,207	1,166	1,902
590	2,347	0,108	0,207	1,168	1,921
591	2,37	0,107	0,207	1,168	1,94
592	2,396	0,107	0,206	1,17	1,957
593	2,42	0,107	0,206	1,171	1,976
594	2,441	0,106	0,205	1,173	1,993
595	2,462	0,106	0,205	1,174	2,008
596	2,483	0,106	0,205	1,175	2,023
597	2,501	0,105	0,205	1,177	2,038
598	2,518	0,105	0,205	1,177	2,051
599	2,536	0,105	0,205	1,178	2,065
600	2,552	0,105	0,204	1,179	2,078
601	2,564	0,104	0,204	1,179	2,09
602	2,581	0,104	0,205	1,179	2,101
603	2,595	0,103	0,204	1,18	2,113
604	2,611	0,103	0,204	1,18	2,125
605	2,622	0,103	0,203	1,181	2,136
606	2,635	0,103	0,203	1,182	2,147
607	2,649	0,102	0,202	1,182	2,158
608	2,661	0,102	0,202	1,182	2,171

609	2,677	0,102	0,202	1,181	2,182
610	2,689	0,101	0,201	1,182	2,195
611	2,703	0,101	0,201	1,182	2,206
612	2,715	0,101	0,2	1,183	2,217
613	2,731	0,1	0,2	1,183	2,229
614	2,741	0,1	0,2	1,183	2,24
615	2,75	0,1	0,199	1,182	2,251
616	2,765	0,099	0,199	1,181	2,259
617	2,771	0,099	0,198	1,181	2,268
618	2,777	0,099	0,198	1,179	2,273
619	2,783	0,098	0,197	1,178	2,277
620	2,783	0,098	0,196	1,176	2,278
621	2,786	0,098	0,196	1,173	2,279
622	2,779	0,098	0,195	1,172	2,275
623	2,774	0,097	0,194	1,17	2,268
624	2,766	0,097	0,193	1,168	2,26
625	2,754	0,097	0,192	1,167	2,247
626	2,739	0,096	0,192	1,165	2,231
627	2,72	0,096	0,191	1,164	2,214
628	2,696	0,096	0,19	1,161	2,191
629	2,665	0,096	0,19	1,158	2,164
630	2,633	0,095	0,19	1,156	2,133
631	2,594	0,095	0,191	1,152	2,098
632	2,547	0,095	0,19	1,149	2,06
633	2,5	0,095	0,19	1,145	2,019
634	2,442	0,094	0,189	1,14	1,975
635	2,386	0,094	0,189	1,136	1,929
636	2,328	0,094	0,187	1,13	1,882
637	2,268	0,094	0,187	1,124	1,835
638	2,211	0,094	0,186	1,119	1,791
639	2,156	0,093	0,186	1,113	1,748
640	2,103	0,093	0,185	1,107	1,709
641	2,054	0,093	0,184	1,101	1,673
642	2,01	0,093	0,184	1,095	1,64
643	1,972	0,092	0,184	1,089	1,611
644	1,94	0,092	0,183	1,084	1,587
645	1,914	0,092	0,183	1,079	1,567
646	1,893	0,092	0,183	1,074	1,552
647	1,874	0,092	0,182	1,07	1,538
648	1,859	0,092	0,183	1,067	1,528
649	1,845	0,092	0,182	1,065	1,518
650	1,831	0,092	0,182	1,063	1,508
651	1,814	0,092	0,183	1,061	1,496

652	1,794	0,092	0,183	1,058	1,481
653	1,769	0,092	0,183	1,054	1,463
654	1,736	0,092	0,183	1,048	1,439
655	1,696	0,092	0,184	1,04	1,411
656	1,648	0,092	0,184	1,03	1,379
657	1,59	0,092	0,184	1,017	1,339
658	1,523	0,092	0,184	1,001	1,292
659	1,452	0,092	0,184	0,981	1,242
660	1,376	0,092	0,185	0,957	1,188
661	1,298	0,092	0,184	0,93	1,132
662	1,219	0,092	0,184	0,9	1,076
663	1,138	0,092	0,185	0,867	1,02
664	1,06	0,092	0,186	0,833	0,967
665	0,988	0,093	0,187	0,8	0,918
666	0,92	0,093	0,188	0,766	0,871
667	0,856	0,093	0,189	0,732	0,826
668	0,8	0,093	0,19	0,7	0,787
669	0,747	0,093	0,189	0,669	0,75
670	0,702	0,092	0,188	0,639	0,717
671	0,661	0,092	0,186	0,613	0,689
672	0,624	0,091	0,184	0,587	0,662
673	0,589	0,091	0,181	0,563	0,638
674	0,559	0,09	0,178	0,542	0,617
675	0,53	0,089	0,175	0,521	0,596
676	0,503	0,089	0,171	0,5	0,576
677	0,479	0,088	0,17	0,482	0,558
678	0,455	0,087	0,167	0,464	0,542
679	0,433	0,087	0,164	0,448	0,526
680	0,413	0,086	0,162	0,433	0,512
681	0,394	0,086	0,16	0,419	0,499
682	0,376	0,085	0,158	0,406	0,486
683	0,359	0,085	0,156	0,394	0,474
684	0,343	0,084	0,155	0,382	0,463
685	0,329	0,084	0,157	0,371	0,453
686	0,315	0,084	0,156	0,361	0,443
687	0,302	0,083	0,155	0,352	0,434
688	0,29	0,083	0,154	0,343	0,425
689	0,279	0,083	0,154	0,335	0,418
690	0,269	0,083	0,153	0,327	0,411
691	0,26	0,083	0,152	0,32	0,404
692	0,251	0,082	0,151	0,313	0,397
693	0,242	0,082	0,15	0,307	0,391
694	0,234	0,082	0,149	0,301	0,385

695	0,227	0,082	0,149	0,296	0,38
696	0,221	0,082	0,148	0,291	0,376
697	0,214	0,081	0,147	0,286	0,371
698	0,208	0,081	0,147	0,281	0,366
699	0,203	0,081	0,146	0,277	0,362
700	0,198	0,081	0,145	0,273	0,358

LAMPIRAN 3

DATASHEET TCO (TRANSPARENT CONDUCTIVE OXIDE)

SIGMA-ALDRICH

sigma-aldrich.com

SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006

Version 4.1 Revision Date 14.01.2012

Print Date 01.05.2014

GENERIC EU MSDS - NO COUNTRY SPECIFIC DATA - NO OEL DATA

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING**1.1 Product identifiers**

Product name : Indium tin oxide coated glass slide, rectangular

Product Number : 636916

Brand : Aldrich

CAS-No. : 50926-11-9

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheetCompany : Sigma-Aldrich Pte Ltd
1 Science Park Road
#02-14 The Capricorn
Singapore Science Park Road II
SINGAPORE 117528
SINGAPORE

Telephone : +65 6779 1200

Fax : +65 6779 1822

1.4 Emergency telephone number

Emergency Phone # : 1-800-262-8200

2. HAZARDS IDENTIFICATION**2.1 Classification of the substance or mixture**

Classification according to Regulation (EC) No 1272/2008 [EU-GHS/CLP]

Skin irritation (Category 2)

Eye irritation (Category 2)

Specific target organ toxicity - single exposure (Category 3)

Classification according to EU Directives 67/548/EEC or 1999/45/EC

Irritating to eyes, respiratory system and skin.

2.2 Label elements

Labelling according Regulation (EC) No 1272/2008 [CLP]

Pictogram



Signal word : Warning

Hazard statement(s)

H315 : Causes skin irritation.

H319 : Causes serious eye irritation.

H335 : May cause respiratory irritation.

Precautionary statement(s)

P261 : Avoid breathing dust.

P305 + P351 + P338 : IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Supplemental Hazard Statements : none

According to European Directive 67/548/EEC as amended.

Hazard symbol(s)



R-phrase(s)

R36/37/38

Irritating to eyes, respiratory system and skin.

S-phrase(s)

S26

In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

2.3 Other hazards - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.2 Mixtures

Synonyms : ITO coated slide, rectangular

Component	Classification	Concentration
Diindium trioxide		
CAS-No. 1312-43-2	Skin Irrit. 2; Eye Irrit. 2; STOT SE 3; H315, H319, H335 Xi, R36/37/38	50 - 100 %
EC-No. 215-193-9		
Tin(IV) oxide***		
CAS-No. 18282-10-5	-	10 - 20 %
EC-No. 242-159-0		

* PBT substance, ** vPvB substance, *** WEL substance

For the full text of the H-Statements and R-Phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice

Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Wash off with soap and plenty of water. Consult a physician.

In case of eye contact

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

4.3 Indication of any immediate medical attention and special treatment needed

no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Tin/tin oxides, Indium/indium oxides

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data available

6. ACCIDENTAL RELEASE MEASURES**6.1 Personal precautions, protective equipment and emergency procedures**

Use personal protective equipment. Avoid dust formation. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.

6.2 Environmental precautions

Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up

Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. HANDLING AND STORAGE**7.1 Precautions for safe handling**

Avoid contact with skin and eyes. Avoid formation of dust and aerosols. Provide appropriate exhaust ventilation at places where dust is formed.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end uses

no data available

8. EXPOSURE CONTROLS/PERSONAL PROTECTION**8.1 Control parameters**

Components with workplace control parameters

8.2 Exposure controls**Appropriate engineering controls**

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment**Eye/face protection**

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

impervious clothing. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

For nuisance exposures use type P95 (US) or type P1 (EU EN 143) particle respirator. For higher level protection use type OV/AG/P99 (US) or type ABEK-P2 (EU EN 143) respirator cartridges. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

9. PHYSICAL AND CHEMICAL PROPERTIES
9.1 Information on basic physical and chemical properties

a) Appearance	Form: solid
b) Odour	no data available
c) Odour Threshold	no data available
d) pH	no data available
e) Melting point/freezing point	no data available
f) Initial boiling point and boiling range	no data available
g) Flash point	no data available
h) Evaporation rate	no data available
i) Flammability (solid, gas)	no data available
j) Upper/lower flammability or explosive limits	no data available
k) Vapour pressure	no data available
l) Vapour density	no data available
m) Relative density	1,200 g/cm ³
n) Water solubility	no data available
o) Partition coefficient: n-octanol/water	no data available
p) Autoignition temperature	no data available
q) Decomposition temperature	no data available
r) Viscosity	no data available
s) Explosive properties	no data available
t) Oxidizing properties	no data available

9.2 Other safety information

no data available

10. STABILITY AND REACTIVITY
10.1 Reactivity

no data available

10.2 Chemical stability

no data available

10.3 Possibility of hazardous reactions

no data available

10.4 Conditions to avoid

no data available

- 10.5 Incompatible materials**
Strong oxidizing agents, Potassium, Strong acids, Aluminum, Sodium/sodium oxides, Magnesium
- 10.6 Hazardous decomposition products**
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
no data available

Skin corrosion/irritation
no data available

Serious eye damage/eye irritation
no data available

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Reproductive toxicity
no data available

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Potential health effects

Inhalation	May be harmful if inhaled. Causes respiratory tract irritation.
Ingestion	May be harmful if swallowed.
Skin	May be harmful if absorbed through skin. Causes skin irritation.
Eyes	Causes serious eye irritation.

Signs and Symptoms of Exposure

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Additional Information
RTECS: Not available

12. ECOLOGICAL INFORMATION

12.1 Toxicity
no data available

12.2 Persistence and degradability
no data available

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

LAMPIRAN 4

DATASHEET TiO₂

SIGMA-ALDRICHsigma-aldrich.com**SAFETY DATA SHEET**

according to Regulation (EC) No. 1907/2006

Version 5.4 Revision Date 13.03.2014

Print Date 01.05.2014

GENERIC EU MSDS - NO COUNTRY SPECIFIC DATA - NO OEL DATA

SECTION 1: Identification of the substance/mixture and of the company/undertaking**1.1 Product identifiers**

Product name : Titanium(IV) oxide

Product Number : 718467

Brand : Aldrich

REACH No. : A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

CAS-No. : 13463-67-7

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheetCompany : Sigma-Aldrich Pte Ltd
1 Science Park Road
#02-14 The Capricorn
Singapore Science Park Road II
SINGAPORE 117528
SINGAPORE

Telephone : +65 6779 1200

Fax : +65 6779 1822

1.4 Emergency telephone number

Emergency Phone # : 1-800-262-8200

SECTION 2: Hazards identification**2.1 Classification of the substance or mixture**

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

This substance is not classified as dangerous according to Directive 67/548/EEC.

2.2 Label elements

The product does not need to be labelled in accordance with EC directives or respective national laws.

2.3 Other hazards - none**SECTION 3: Composition/information on ingredients****3.1 Substances**Formula : O₂Ti

Molecular Weight : 79.87 g/mol

CAS-No. : 13463-67-7

EC-No. : 236-675-5

No components need to be disclosed according to the applicable regulations.

SECTION 4: First aid measures**4.1 Description of first aid measures****General advice**

Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Wash off with soap and plenty of water. Consult a physician.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

no data available

SECTION 5: Firefighting measures**5.1 Extinguishing media****Suitable extinguishing media**

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Titanium/titanium oxides

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data available

SECTION 6: Accidental release measures**6.1 Personal precautions, protective equipment and emergency procedures**

Use personal protective equipment. Avoid dust formation. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Avoid breathing dust.

For personal protection see section 8.

6.2 Environmental precautions

Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up

Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage**7.1 Precautions for safe handling**

Provide appropriate exhaust ventilation at places where dust is formed.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Full contact

Material: Nitrile rubber

Minimum layer thickness: 0,11 mm

Break through time: 480 min

Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact

Material: Nitrile rubber

Minimum layer thickness: 0,11 mm

Break through time: 480 min

Material tested: Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de,

test method: EN374

If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection

Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure

Do not let product enter drains.

SECTION 9: Physical and chemical properties**9.1 Information on basic physical and chemical properties**

a) Appearance	Form: nano particles Colour: white
b) Odour	no data available
c) Odour Threshold	no data available
d) pH	no data available
e) Melting point/freezing point	Melting point/range: 1.850 °C
f) Initial boiling point and boiling range	no data available
g) Flash point	no data available
h) Evaporation rate	no data available
i) Flammability (solid, gas)	no data available
j) Upper/lower flammability or explosive limits	no data available
k) Vapour pressure	no data available
l) Vapour density	no data available
m) Relative density	no data available
n) Water solubility	no data available
o) Partition coefficient: n-octanol/water	no data available
p) Auto-ignition temperature	no data available
q) Decomposition temperature	no data available
r) Viscosity	no data available
s) Explosive properties	no data available
t) Oxidizing properties	no data available

9.2 Other safety information
no data available

SECTION 10: Stability and reactivity**10.1 Reactivity**

no data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

no data available

10.4 Conditions to avoid

no data available

10.5 Incompatible materials

Strong acids

10.6 Hazardous decomposition products

Other decomposition products - no data available
In the event of fire: see section 5

SECTION 11: Toxicological information**11.1 Information on toxicological effects****Acute toxicity**

LD50 Oral - rat - > 10.000 mg/kg

LD50 Dermal - rabbit - > 10.000 mg/kg

Skin corrosion/irritation

Skin - Human

Result: Mild skin irritation - 3 h

Serious eye damage/eye irritation

Eyes - rabbit

Result: No eye irritation

Respiratory or skin sensitisation

Will not occur

Germ cell mutagenicity

Hamster

ovary

Micronucleus test

Hamster

Lungs

DNA inhibition

Hamster

ovary

Sister chromatid exchange

mouse

Micronucleus test

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Reproductive toxicity

no data available

Specific target organ toxicity - single exposure

no data available

Specific target organ toxicity - repeated exposure

no data available

Aspiration hazard

no data available

Additional Information

RTECS: XR2275000

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

SECTION 12: Ecological information**12.1 Toxicity**

Toxicity to fish

LC50 - other fish - > 1.000 mg/l - 96 h

Aldrich - 718467

Page 5 of 7

SIGMA-ALDRICH

sigma-aldrich.com

3050 Spruce Street, Saint Louis, MO 63103, USA

Website: www.sigmaldrich.comEmail USA: techserv@sial.comOutside USA: eurtechserv@sial.com

Product Specification

Product Name:

Titanium(IV) oxide, anatase - nanopowder, <25 nm particle size, 99.7% trace metals basis

Product Number: 637254
CAS Number: 1317-70-0
MDL: MFCD00011269
Formula: O₂Ti
Formula Weight: 79.87 g/mol



TEST	Specification
Appearance (Color)	White
Appearance (Form)	Powder
X-Ray Diffraction	Conforms to Structure
Particle Size	≤ 25 nm
Surface Area	45 - 65 m ² /g
ICP Major Analysis	Confirmed
Confirms Titanium Component	
Purity	Meets Requirements
99.7% Based On Trace Metals Analysis	
Trace Metal Analysis	≤ 4000.0 ppm

Specification: PRD.0.ZQ5.10000056619

Sigma-Aldrich warrants, that at the time of the quality release or subsequent retest date this product conformed to the information contained in this publication. The current Specification sheet may be available at Sigma-Aldrich.com. For further inquiries, please contact Technical Service. Purchaser must determine the suitability of the product for its particular use. See reverse side of invoice or packing slip for additional terms and conditions of sale.

LAMPIRAN 5

**DATASHEET SCANNING ELECTRON MICROSCOPE PHENOMPRO
G2PRO**

Specification Sheet | **Microscopes**

Phenom Pro

Most professional desktop SEM imaging



Phenom Pro

High-end desktop SEM with superb imaging power

Magnification

Magnification range up to 130,000x

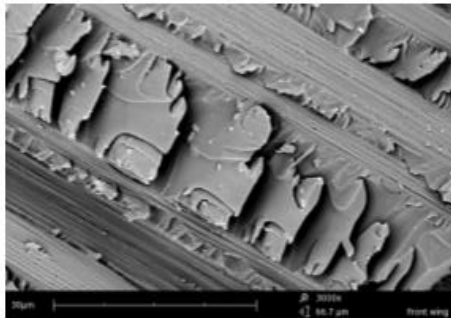
Acceleration voltages

Between 5 kV and 10 kV acceleration voltages for the best resolution on a large variety of samples

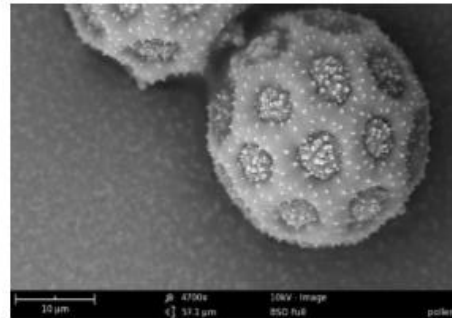
Never lost navigation

Swift navigation to any region of interest

PHENOMWORLD



Carbon fiber composites material



Pollen

The Phenom Pro is Phenom-World's high-end imaging desktop scanning electron microscope (SEM). In combination with a large range of sample holders and automated system software, it can be tailored to suit a multitude of applications.

Phenom Pro

Phenom-World is focused on enabling its customers to keep pace with continuously shrinking feature sizes and to increase productivity while bringing down the costs of analysis. The Phenom Pro is the most effective and fastest imaging oriented desktop SEM on the market. Its unique design makes it suitable for use in a wide variety of applications and markets. With custom made detection hardware, a high brightness source and a state of the art color navigation camera, it is an extremely powerful desktop SEM. The zoom functionality of the color navigation camera narrows the gap between optical and SEM imaging.

The Phenom Pro is the platform that offers automated and mechanized accessories such as ProSuite and active sample holders.

The Phenom Pro can be upgraded to Phenom ProX with EDS or equipped with the Phenom ProSuite application platform.

Imaging Specifications

Imaging modes

- Light optical Magnification range: 20 - 135x
- Electron optical Magnification range: 80 - 130,000x
- Digital zoom max: 12x

Illumination

- Light optical Bright field / dark field modes
- Electron optical Long lifetime thermionic source (CeB₆)
- Acceleration voltages Default: 5 kV, 10 kV
- Advanced mode: adjustable range between 4.8 kV and 10 kV imaging mode
- Resolution ≤ 10 nm

Digital image detection

- Light optical Color navigation camera
- Electron optical High sensitivity backscattered electron detector (compositional and topographical modes)

Image formats

JPEG, TIFF, BMP

Image resolution options

456 x 456, 684 x 684, 1024 x 1024 and 2048 x 2048 pixels

Data storage

- USB flash drive
- Network

Sample stage

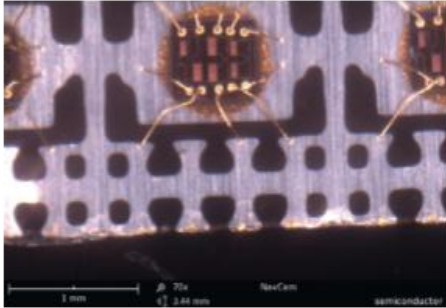
Computer-controlled motorized X and Y

Sample size

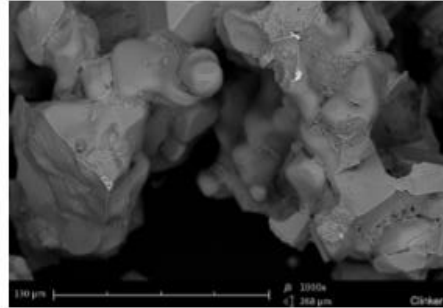
- Up to 32 mm (Ø)
- Up to 100 mm (h)

Sample loading time

- Light optical < 5 s
- Electron optical < 30 s



Example of a chip viewed with the navcam



Cement sample

Never lost navigation

The color navigation camera in the Phenom Pro provides information that helps the operator to make a link between the optical and electron optical images. Users are ready to take images after only 10 minutes of basic training. A large variety of sample holders is available to accommodate a large range of samples. Sample loading is fast and easy due to our patented sample vacuum loading technology.

The optical camera, motorized stage and intuitive user interface work together to help navigate swiftly to any region of interest. Upon clicking on the position of the optical image to investigate, the stage automatically centers the region of interest. Switching to electron imaging mode is fully automated and fast at the

touch of just one button. A high resolution image is available within 30 seconds after loading the sample. Saving images is practical and easy on a USB memory stick or network storage location for offline analysis and distribution.

The Phenom Pro is equipped with two acceleration voltages: 5 kV and 10 kV. This allows the users to make higher resolution images at the same magnification, providing even more details from the sample than before. At the same time, the Phenom Pro can be used with the lower beam current setting. The combination of two different acceleration voltages and two beam current settings offers a high level of flexibility, creating the best results for a large variety of samples.

System Specifications

System	<ul style="list-style-type: none"> - Imaging module - 19" monitor - Rotary knob - Mouse - Diaphragm vacuum pump - Power supply - USB flash drive
Dimensions & weight	
• Imaging module	286(w) x 566(d) x 495(h) mm, 50 kg
• Diaphragm vacuum pump	145(w) x 220(d) x 213(h) mm, 4.5 kg
• Power supply	156(w) x 300(d) x 74(h) mm, 3 kg
• Monitor	375(w) x 203(d) x 395(h) mm, 7.9 kg

Requirements

Ambient conditions	
• Temperature	15°C - 30°C (59°F - 86°F)
• Humidity	< 80 % RH
• Power	Single phase AC 110 - 240 Vdlt, 50/60 Hz, 300 W (max.)
Recommended table size	120 x 75 cm, load rating of 100 kg



ProSuite

ProSuite

ProSuite is an optional application platform that has been developed to further enhance the capabilities of the Phenom system. ProSuite enables maximum information to be extracted from images obtained on the Phenom imaging system. It offers multiple solutions to specific application needs. ProSuite contains standard applications such as Automated Image Mapping and Remote User Interface. Optional applications are 3D Roughness Reconstruction, FiberMetric, ParticleMetric, and PoroMetric. Virtually all the properties of a sample can be revealed using the Phenom desktop SEM in combination with ProSuite.



Phenom ProX

Upgrade to Phenom ProX

The Phenom ProX is the ultimate all-in-one imaging and X-ray analysis system. With the Phenom ProX, sample structures can be physically examined and their elemental composition determined. The optional Elemental Mapping and Line Scan software allows further analysis of the distribution of elements. A dedicated software package is included and installed on the ProSuite PC to control the fully integrated EDS detector. Analysis has become as easy as imaging, since there is no need to switch between external software packages or computers. The latest Phenom Pro models can be upgraded to Phenom ProX at Phenom-World service hubs.

ProSuite Specifications

System	<ul style="list-style-type: none"> Automated collection of images Real-time remote control Intuitive single page user interface Standard applications included: Automated Image Mapping & Remote User Interface
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Optional

3D Roughness Reconstruction	<ul style="list-style-type: none"> Based on "shape from shading" technology, no stage tilt required Fast reconstruction
FiberMetric	<ul style="list-style-type: none"> Fast and automated collection of all statistical data Large range of fibers and pores can be measured
ParticleMetric	Morphology and particle size data for submicron particle applications
PoroMetric	Fully automated visualization and analysis of pores

EDS Specifications

Detector type	<ul style="list-style-type: none"> Silicon Drift Detector (SDD) Thermoelectrically cooled (LN₂ free)
Detector active area	25 mm ²
X-ray window	Ultra thin Silicon Nitride (Si ₃ N ₄) window allowing detection of elements B to Am
Energy resolution	Mn Kα ≤ 137 eV
Processing capabilities	Multi-channel analyzer with 2048 channels at 10 eV/ch
Max. input count rate	300,000 cps
Hardware integration	Fully embedded
Software	<ul style="list-style-type: none"> Integrated in Phenom ProSuite Integrated column and stage control Auto-peak ID Iterative strip peak deconvolution Confidence of analysis indicator Export functions: CSV, JPG, TIFF, ELID, EMSA
Report	Docx format