Supplemental Information

Improved Cut-Resistance of Kevlar® using Controlled Interface Reactions during Atomic Layer Deposition of Ultrathin (<50Å) Inorganic Coatings

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Table S1. Statistical analysis for TiO_2 treated PPTA. Mean = average; SD = Standard Deviation; df = degrees of freedom; t= t-value; N/A = rejected test due to apparatus failure.

		Peak load (N)					
TiO_2		**50°C**			**100°C**		
Sample No.	**Neat**	**25A TiO2**	**100A TiO2**	**400A TiO_2**	**25A TiO2**	**100A TiO2**	**400A TiO2**
1	4.484	5.672	5.183	3.964	3.791	4.004	4.434
2	5.599	5.327	5.557	5.080	3.554	3.695	3.646
3	5.325	5.043	5.416	4.371	3.479	3.993	3.650
4	5.188	6.047	5.289	4.702	4.301	4.035	3.662
5	4.320	4.819	5.629	4.108	3.833	3.431	4.063
6	4.050	5.091	5.159	4.698	3.883	3.821	4.357
7	4.969	5.405	4.975	4.596	4.059	**N/A**	4.235
8	4.902	5.165	5.200	4.401	4.043	3.792	3.932
9	5.618	4.799	5.755	4.654	3.933	3.401	3.823
10	4.615	**N/A**	4.982	3.744	3.916	3.498	4.034
Mean	4.907	5.263	5.315	4.432	3.879	3.741	3.984
SD	0.536	0.404	0.267	0.400	0.240	0.250	0.293
df	--	17	18	18	18	17	18
t	--	1.644	2.154	2.245	5.537	6.173	4.779

Table S2. Statistical analysis for Al_2O_3 treated PPTA. Mean = average; SD = Standard Deviation; df = degrees of freedom; t= t-value.

		Peak load (N)					
Al_2O_3		**50°C**			**100°C**		
Sample No.	**Neat**	**25A Al2O3**	**100A Al2O3**	**400A Al2O3**	**25A Al2O3**	**100A Al2O3**	**400A Al2O3**
1	4.484	4.643	4.484	3.634	3.507	4.420	3.966
2	5.599	4.979	4.158	3.969	4.031	3.517	3.693
3	5.325	4.507	4.483	3.409	4.121	3.901	3.649
4	5.188	4.747	4.079	3.738	3.548	3.402	3.832
5	4.320	4.765	4.290	3.796	3.392	3.926	4.121
6	4.050	4.886	4.144	3.878	3.576	3.565	3.775
7	4.969	5.453	4.230	3.679	3.734	4.385	4.135
8	4.902	4.433	N/A	3.853	3.946	3.437	4.057
9	5.618	4.989	3.656	3.794	3.908	4.461	4.150
10	4.615	4.468	3.712	3.934	4.024	3.552	3.935
Mean	4.907	4.787	4.137	3.768	3.779	3.857	3.931
SD	0.536	0.309	0.293	0.165	0.259	0.427	0.187
df	--	18	18	18	18	18	18
t	--	0.613	3.991	6.424	5.991	4.843	5.439

Table S3. Statistical analysis for TiO_2 / Al_2O_3 treated PPTA. Mean = average; SD = Standard Deviation; df = degrees of freedom; t= t-value.

Coated at 50°C	**Peak load (N)**			
Sample No.	**Neat**	**10A TiO2 / 10A Al2O3**	**25A TiO2 / 25A Al2O3**	**50A TiO2 / 50A Al2O3**
1	4.792	5.241	5.444	5.616
2	4.604	5.084	6.176	7.157
3	4.444	5.031	6.470	5.857
4	5.656	5.568	5.895	6.925
5	4.957	5.711	4.951	6.853
6	6.125	5.343	5.857	5.534
7	4.768	5.771	5.450	7.225
8	5.370	5.506	7.027	5.807
9	4.988	5.163	4.702	6.375
10	4.439	5.569	5.369	6.389
11	4.655	5.332	4.247	6.907
12	5.004	5.347	6.500	7.556
13	5.441	5.848	6.435	5.603
14	5.485	6.003	5.633	6.089
15	5.502	6.557	7.749	7.434
16	3.881	5.628	5.777	5.941
17	4.212	5.222	6.846	6.709
18	4.089	5.877	6.801	5.925
19	4.661	5.532	6.547	6.246
20	6.222	5.997	6.696	6.998
Mean	4.965	5.567	6.029	6.457
SD	0.641	0.374	0.859	0.648
df	--	38	38	38
t	--	3.628	4.441	7.320

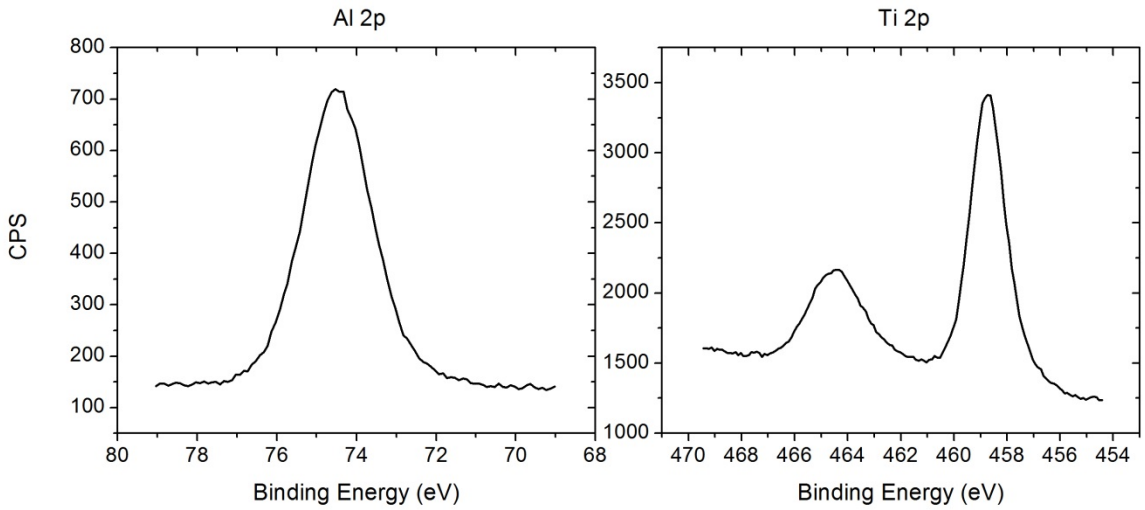

Figure S1. High resolution XPS scans of Al and Ti 2p for Al_2O_3 and TiO_2 ALD on PPTA, respectively. The Al 2p peak is centered at ~74.5 eV, corresponding to the oxide (Al metal ~73 eV). The Ti 2p peak is centered at ~459 eV, which also corresponds to the oxide (Ti metal ~ 454 eV).

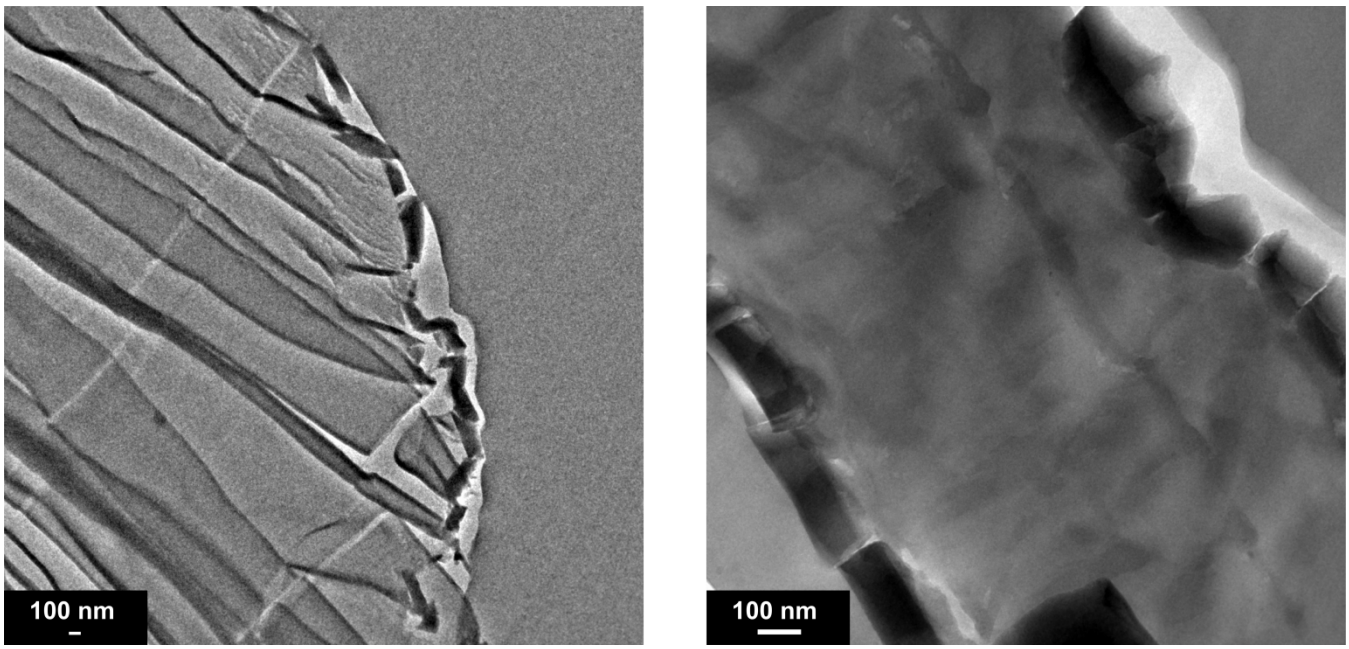

Figure S2: (Left) TEM of 100 nm Al2O3 on PTPA fiber sectioned perpendicular to fiber axis. (Right) TEM of 100 nm Al2O3 on PPTA fiber sectioned parallel with fiber axis. The high contrast layer corresponds to the ALD coating. Folding of the sectioned polymer is also evident.

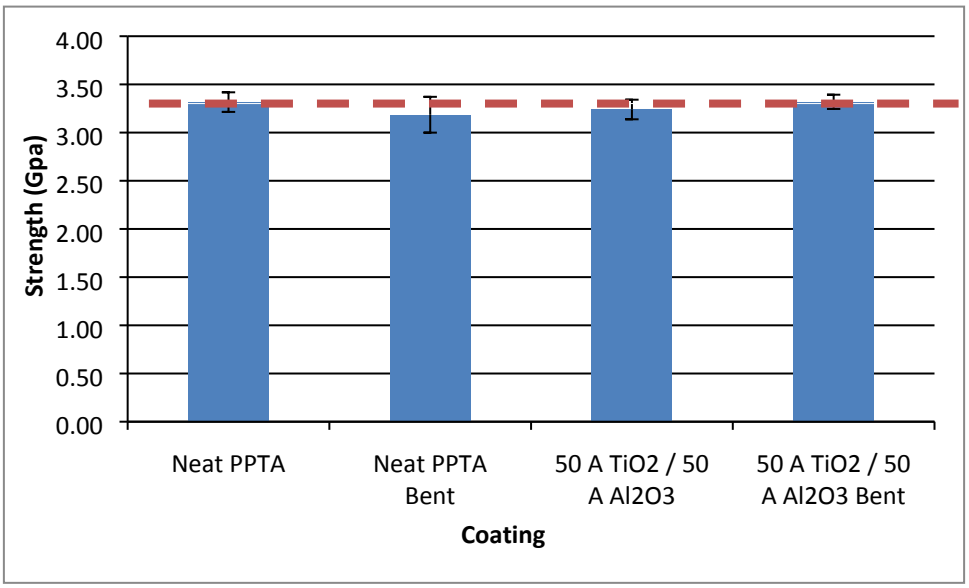

Figure S3: Tensile strength of Neat PPTA and 50Å TiO_2/50Å Al_2O_3 coated PPTA before and after bending. The red dashed line indicates the expected tensile strength of Kevlar KM2.[1] There appears to be no statistically significant change in tensile strength upon bending.

1. T. J. Mulkern and U.S. Army Research Laboratory, *Kevlar KM2 yarn and fabric strength under quasi static tension*, Army Research Laboratory, Aberdeen Proving Ground, MD, 2002.