Supplementary Information

Optimized solder alloy for strong glass-to-metal joints by simultaneous soldering and anodic bonding

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INTERFEROMETRY

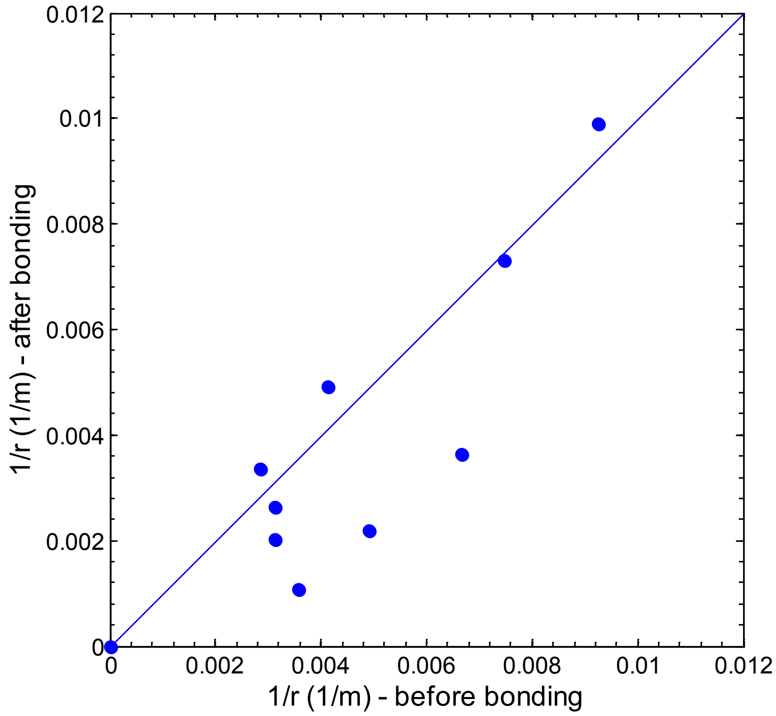


Figure S1. Interferometry results. The curvature, as expressed by 1/r where r is the fitted radius to the interferometry data, does not increase as a result of the anodic bonding process.

Table S1. Interferometry.

Sample #	radius r (m)		1/r (1/m)	
	Before	After	Before	After
201	∞	∞	0.0000	0.0000
202	318	381	0.0031	0.0026
205	349	298	0.0029	0.0034
206	280	938	0.0036	0.0011
207	320	496	0.0031	0.0020
210	134	137	0.0075	0.0073
211	108	101	0.0093	0.0099
212	204	460	0.0049	0.0022
214	150	275	0.0067	0.0036
219	242	204	0.0041	0.0049

The smaller 1/r, the more planar the material.

SHEAR TESTS

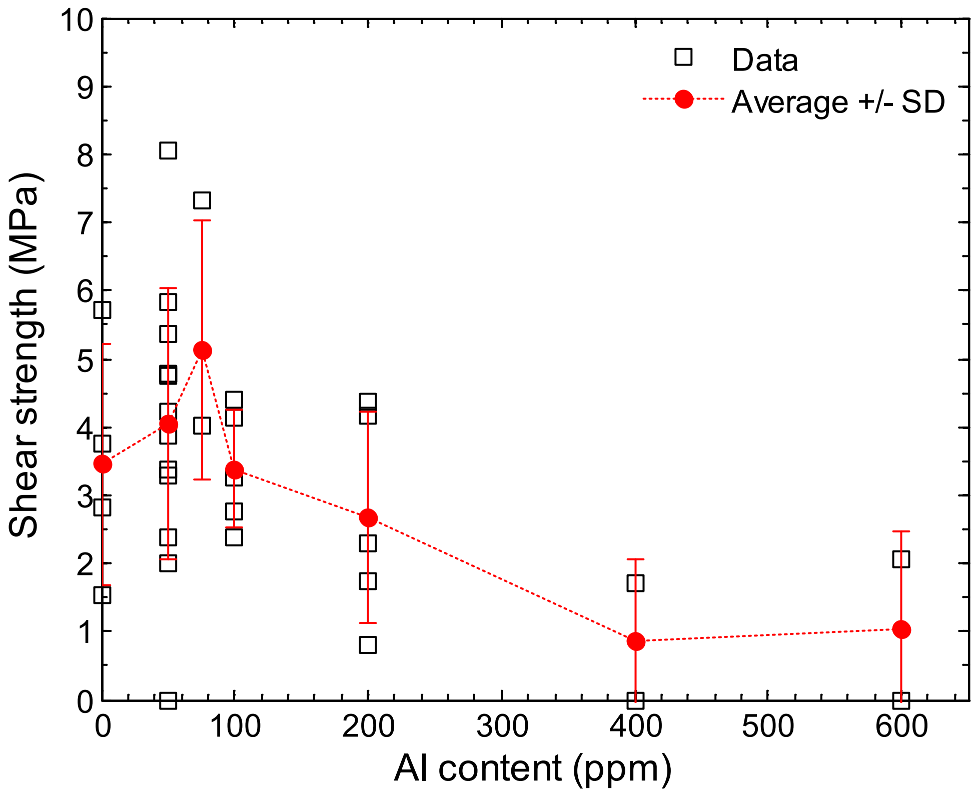


Figure S2. Shear strength (the ratio of the shear force at rupture over the area of the bonded region) as a function of Al content. The shear strength is highest at low, but non-zero Al contents (around 75 ppm). Unfortunately, the variable geometry of the bonded area, combined with the presence of oxides on the part of the specimen where the initial solder coin was placed and the flexibility of the relatively thin Dilaton foil resulted in large scatter on the maximum shear forces when normalized to the bonded surface area.

PEEL TESTS

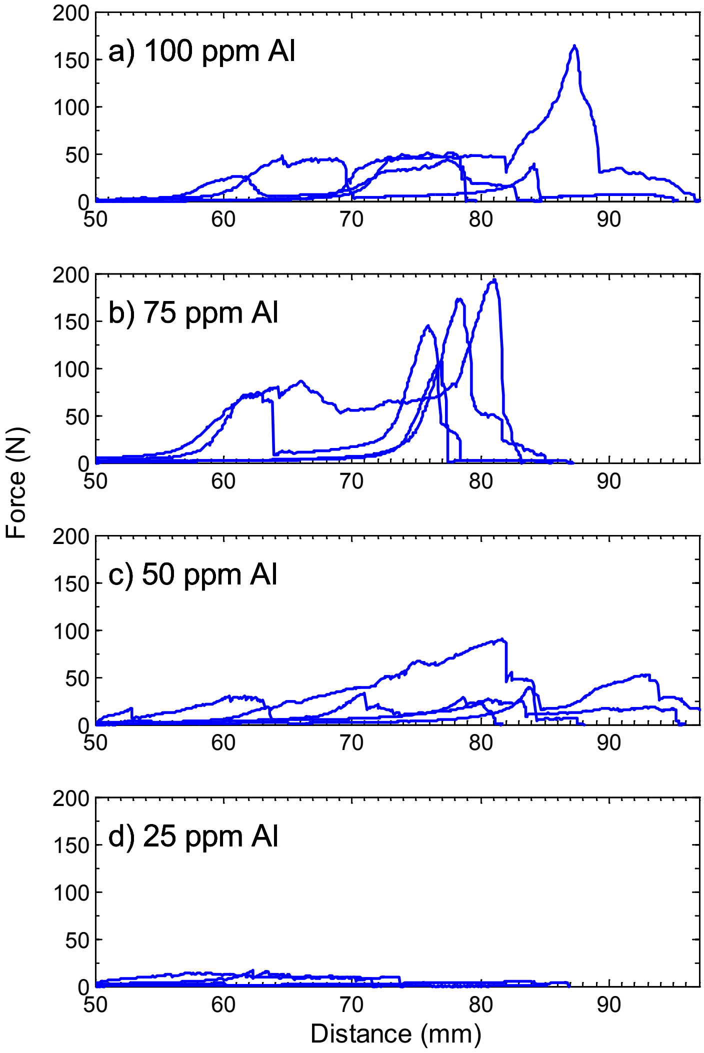


Figure S3. Force profiles during peel testing. The samples with 75 ppm of Al in the solder give consistently high maximum forces. The location of the force maxima is right next to the position of the solder coin, i.e. the solder that travelled the least distance results in maximum bond strength.

Table S2. Peel test results.

Al (ppm)	Maximum force (N)				Mean (N)	SD (N)
	#1	#2	#3	#4		
25	1	5	14	16	9	7
50	30	33	39	90	48	28
75	107	144	173	194	155	38
100	44	48	51	164	77	58

LA-ICPMS ANALYSIS

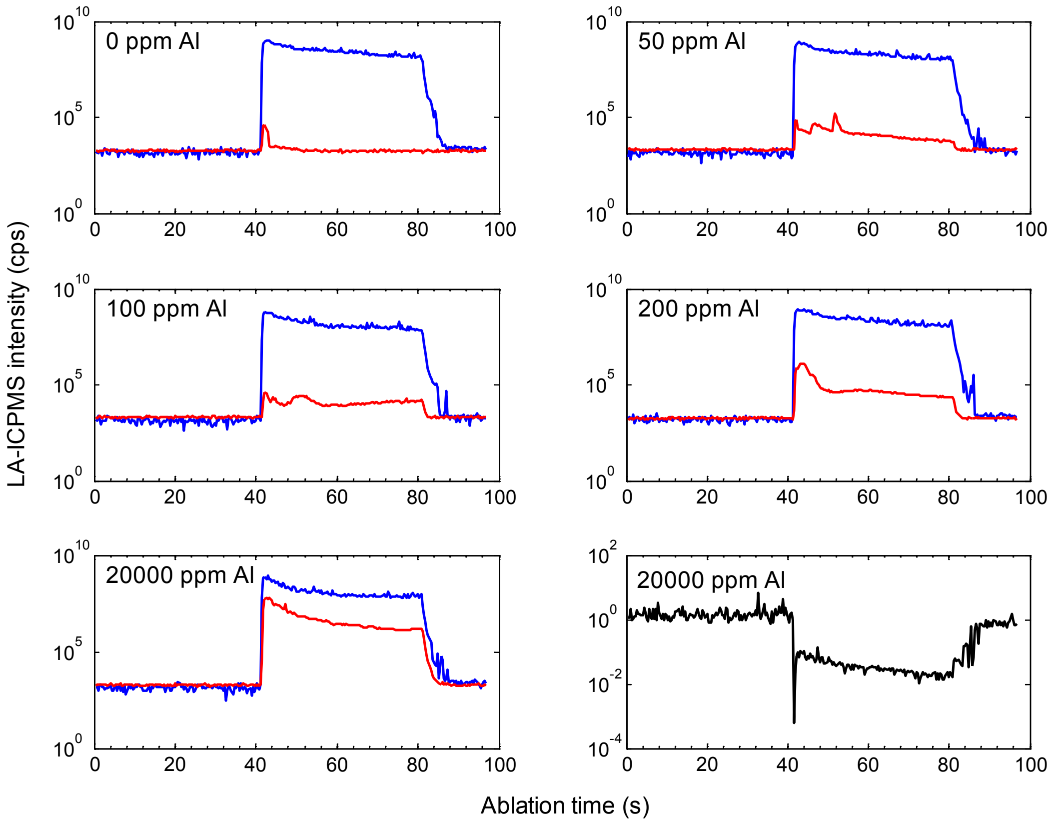


Figure S4. Representative LA-ICPMS profiles for the different solders (red=^{27}Al signal, blue=^{118}Sn signal, black=^{27}Al/^{118}Sn ratio). The strength of the Al signal (red) increases with increasing nominal Al content (indicated in top left corner of each panel). The Al signal displays peaks/spikes near the start of the ablation profile that persist after re-polishing the sample. In addition, elemental fractionation occurs during ablation with nearly an order of magnitude decrease of the ^{27}Al/^{118}Sn ratio during ablation (bottom right panel). Both effects make an accurate quantification of the Al contents exceedingly difficult, but the ^{27}Al count rates nevertheless provide a qualitative measure of the Al content.

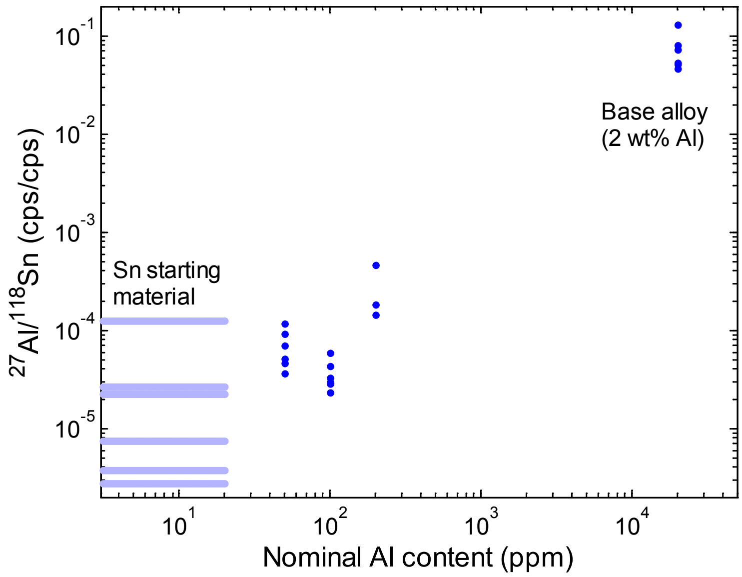
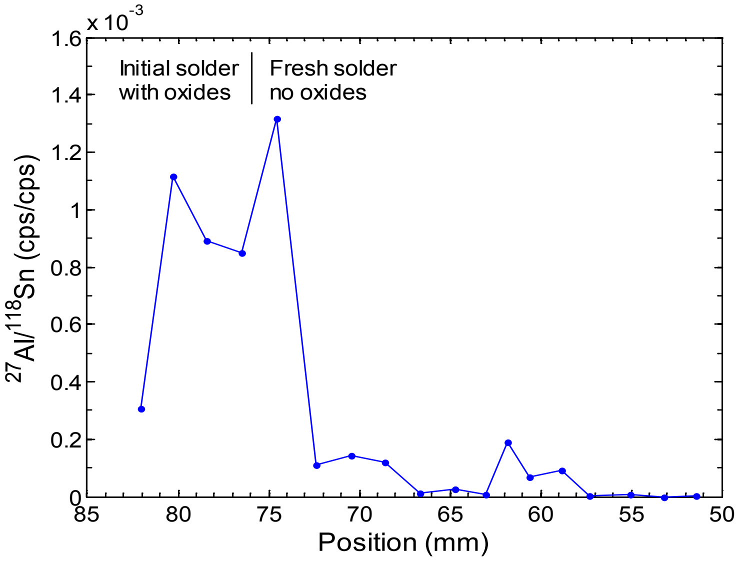


Figure S5. LA-ICPMS results for the Sn-Al solders (integration over the first 30 s of the ablation profiles (Figure S4). The Al counts correlate with the nominal Al content, albeit with significant scatter.

a)

b)



c)

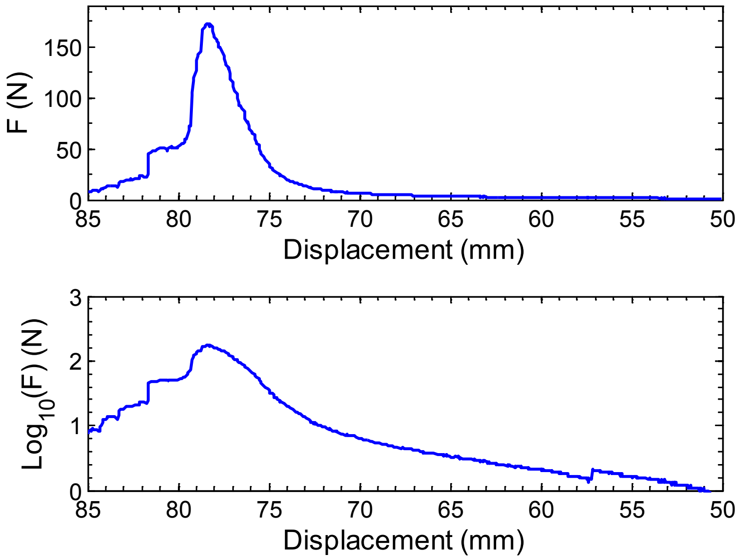


Figure S6. Variation of Al signal and bond strength along the length of a sample for peel testing. The dots on the photograph (a) denote the locations of the LA-ICPMS spots. The Al content decreases with increasing distance from the initial solder coin (b) which is reflected in the peel forces (c) with a small correlated local increase in Al content (near 63 mm) and force (near 57 mm) as well. Note that the values for position (b) and displacement (c) do not align perfectly due to the geometry of the peel tests.