Long-term interactive corrosion between International Simple Glass and stainless steel

Supplementary Information

Chandi Mohanty[1], Xiaolei Guo[1], Huseyin Kaya[2], Stephane Gin[3], Kun Yang[4], Zelong Zhang[5], Seong H. Kim[2], Jie Lian[4], Jianwei Wang[5], Gerald S Frankel[1,*]

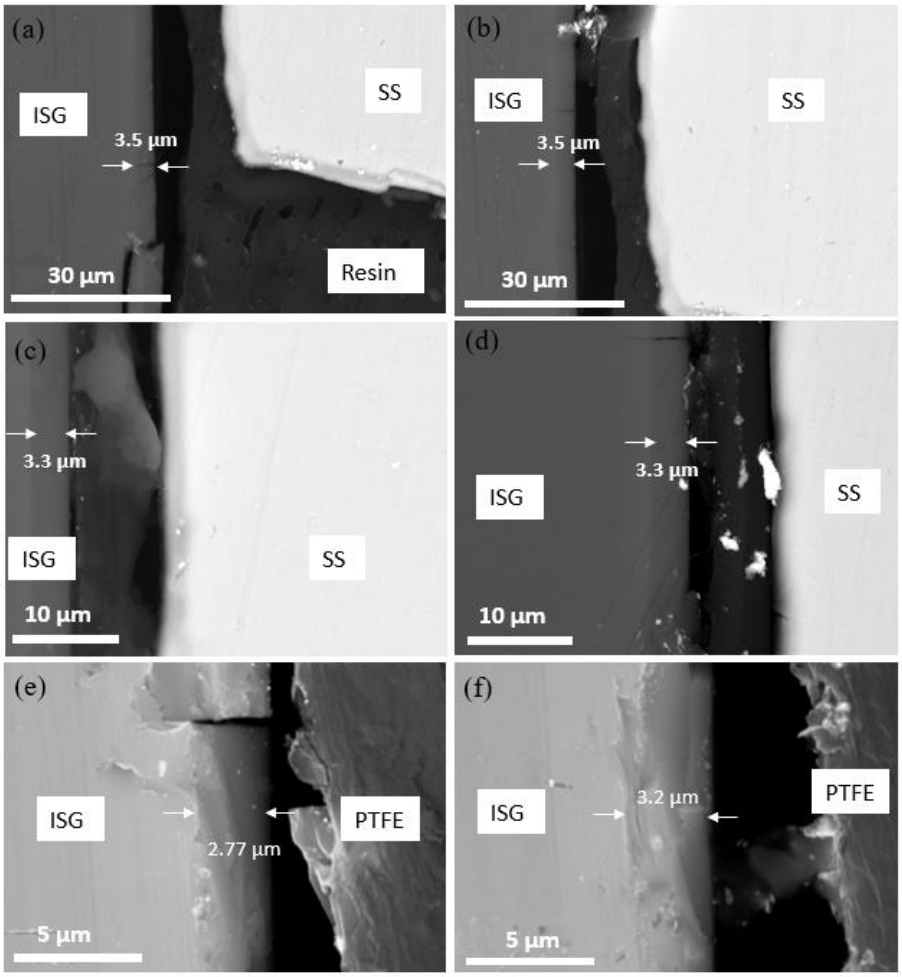
1. Department of Materials Science and Engineering, The Ohio State University, Columbus, OH 43210, United States

2. Department of Chemical Engineering and Materials Research Institute, Pennsylvania State University, University Park, PA 16802, United States

3. CEA, DE2D, University of Montpellier, Marcoule, F-30207 Bagnols sur Cèze, 34000 Montpellier, France

4. Department of Mechanical Aerospace and Nuclear Engineering, Rensselaer Polytechnic Institute, Troy, NY 12180, United States

5. Department of Geology and Geophysics, Louisiana State University, Baton Rouge, Louisiana 70803, United States



Supplementary Figure 1. SEM images of cross sections of ISG(+SS) (a-d) and ISG(+PTFE) (e-f) reacted in silica saturated NaCl solution for 1 year. Cross-section images taken at (a) crevice mouth. (b) 200 µm into the crevice mouth. (c) 400 µm into the crevice mouth. (d) 700 µm into the crevice mouth. (e,f) ISG(+PTFE) cross section image taken at the crevice mouth.

Supplementary Note 1. For ISG(+SS) reacted in 0.6 M NaCl, the gel thickness is seen to decrease along the distance into the crevice (Figure S2 a). This is due to an elevated surface area to volume ratio (SA/V) in the confined crevice region and a low solution renewal rate. For silica saturated solution, the gel thickness is seen not to vary till 1200 μm into the crevice (Figure S2 b). A possible explanation to this discrepancy may lie in the difference in the level of solution renewal in the crevice region since the SA/V ratio may be reasonably assumed to be the same for both the solutions. The crevice mouth region in 0.6 M NaCl could have been more constricted than in silica saturated solution due to the precipitation of secondary phases on the SS surface as seen in Figure 3 in the main text.

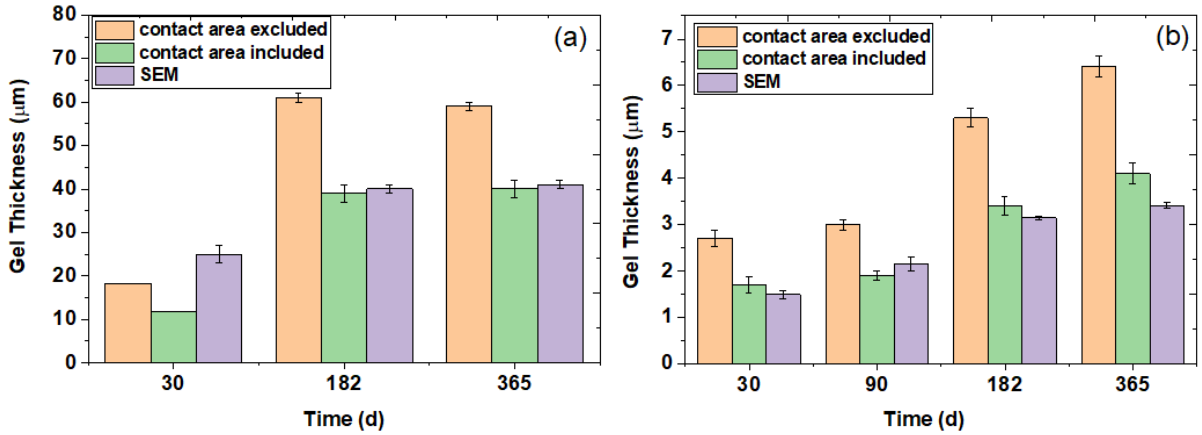
Supplementary Table 1. Results of solution analyses for a) ISG-SS and b) ISG-PTFE dissolution in 0.6 M NaCl. *30 day data taken from Guo et. al.[1] The Al concentration for ISG(+PTFE) was below detection limit (b.d.l). All numbers are in parts per million (ppm). The equivalent thickness ET(B) was estimated by including the ISG (+SS) contact area in the SA/V (ET(B)†) and excluding the ISG(+SS) contact area in the SA/V (ET(B)† †)

a) ICP-OES solution analyses results for ISG(+SS) dissolution in 0.6 M NaCl

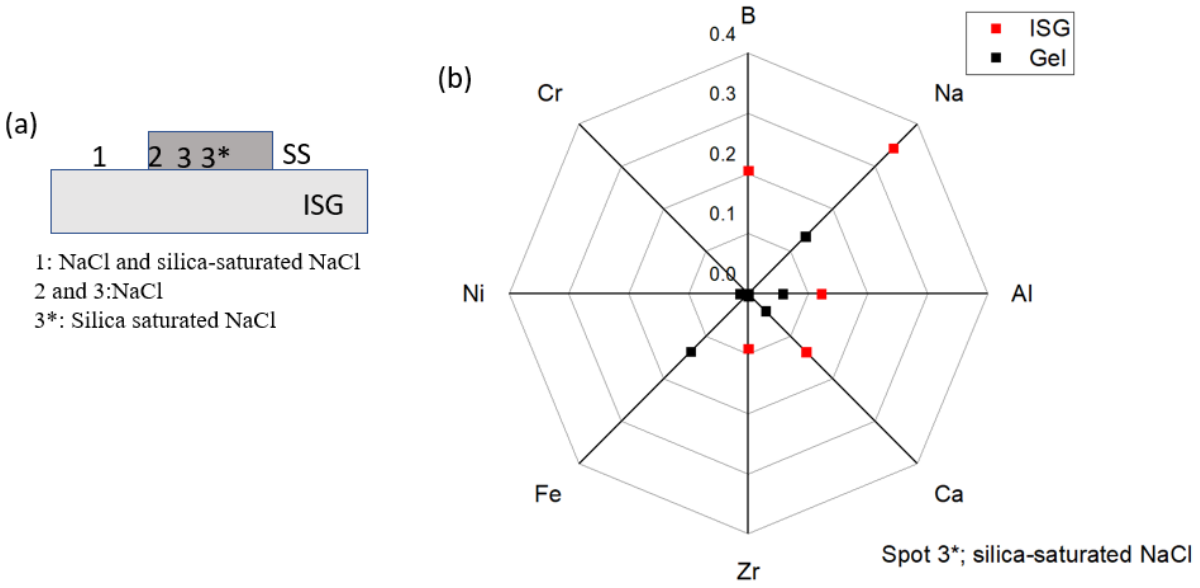
Time (d)	Si	Al	Fe	B	Ca	pH	ET(B)† (μm)	ET(B)† † (μm)
30*	10.4	3.8	< 0.1	6.4	3.7	8.4	11.7	18.2
182	71 ±1	0.02 ± 1	0.16 ± 0.02	44 ± 2	32 ± 2	8.8	39± 2	61± 1
365	64 ± 1	0.02 ±1	0.30 ±0.01	43 ± 2	24 ± 2	8.7	40 ± 2	59± 1

b) ICP-OES solution analyses results for ISG(+PTFE) dissolution in 0.6 M NaCl

Time (d)	Si	Al	Fe	B	Ca	ET(B)† (µm)	ET(B)† † (µm)
30*	9	3.6	-	6.3	3.7	11.5	17.9
182	48± 1	b.d.l	-	34± 1	27±1	31± 1	48 ± 1
365	36 ± 1	b.d.l	-	20± 1	19± 2	18± 1	28 ±1



Supplementary Figure 2. Thickness of the gel layer on ISG(+SS) in bulk solution estimated from solution analyses from B concentration in solution (ET(B)) compared with that measured by SEM observation. ET(B) was estimated by first including and then excluding the ISG(+SS) contact area in SA/V consideration. a) 0.6 M NaCl b) Silica saturated NaCl. 30 day data is from Guo et al.[1]



Supplementary Figure 3. The chemistry of the altered glass surface in terms of weight percent of elements obtained with XPS. a) An illustration of the ISG(+SS) creviced assembly where the numbers 1, 2, 3 and 3*represent the spots at which XPS data were acquired. The data for spots 1,2 and 3 have been shown in the main text. b) The elemental composition of the altered glass surface normalized to Si concentration measured at spot 3* corresponding to silica-saturated NaCl solution

References

1. Guo, X. *et al.* Near-field corrosion interactions between glass and corrosion resistant alloys. *npj Mater Degrad* **4**, 10 (2020).