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Dissolution Kinetics of Glass into HF acid: An Assessment of How Glass Structure Impacts Rate

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Numerous laboratories use HF acid to dissolve silicate glasses for multifarious purposes. HF has been used to fashion channels, tunnels, and "through vias", recess surfaces, and to sculpt three-dimensional features onto glass surfaces. Despite these widespread applications, there is currently no universal understanding for how the chemistry or glass structure impacts dissolution rates. We performed experiments on a wide range of simple, three to four component alumino- and borosilicate glasses over a range of HF concentrations at room *T* to gain a better understanding of the dissolution mechanism. Wafers or coupons of glass were reacted in a rotating bath whose motion kept the solution in contact with glass dilute. Glasses ranged widely in SiO_2 (50 to 100 mol.%) and Al^{3+} or B^{3+}/σ alkali or alkaline earth elements (Li^+, Na^+, Mg^{2+}, Ca^{2+}, Zn^{2+}, Sr^{2+}, and Ba^{2+}) to establish a hierarchy of their effects on the dissolution rate. Characterization by MAS NMR (^{27}Al) and XAS provided a comprehensive picture of the structure of these glasses, in particular the coordination number of Al^{3+} and its dependence on field strength of the modifier cation. Parameterization of the rate equation through a modeling effort revealed the molecular basis for which structural moieties affect dissolution. In summary, the relative impacts of the chemical components of glass on dissolution into HF were determined and will be discussed.