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Predicting the properties of new glasses prior to manufacturing is a topic attracting great industrial and scientific interest. Mechanical properties are currently of particular interest given the increasing demand for stronger, thinner, and more flexible glasses in recent years. However, as a non-equilibrium material, the structure and properties of glass depend not only on its composition, but also on its thermal and pressure histories. Here we review our recent findings regarding the thermal and pressure history dependence of indentation-derived mechanical properties of oxide glasses. We also demonstrate how a combined ion-exchange and isostatic compression approach can be applied to tailor the surface properties of alkali-containing glasses.