Amorphous $MgSiO_3$ and SiO_2 densities at core-mantle boundary conditions

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Modelling the formation and evolution of the deepest parts of the Earth through time requires the densities of solids and melts to be constrained. Indeed, the density contrast between solid and liquid silicate phases at high pressures controls the entrainment or settlement of matter in the lowermost mantle and possible deep magma ocean formation. To constrain the density contrast between crystal and amorphous silicates, we have adapted the X-ray absorption method to the diamond anvil cell to enable density measurements of silicate glasses to be made to unprecedented conditions of high pressure [1]. We have consequently determined the densities of SiO_2 and $MgSiO_3$ glasses up to 90 and 127 GPa, respectively. Our density values for $MgSiO_3$ glass are considerably higher than those previously derived from Brillouin spectroscopy [2] but validate recent ab initio simulations [3]. At the core–mantle boundary (CMB) pressure, the density of $MgSiO_3$ glass is approximately the same as that of $MgSiO_3$ bridgmanite. Taking into account the partitioning of iron into the melt, we conclude that melts are denser than the surrounding solid phases in the lowermost mantle and that melts will be trapped above the CMB [1].

[1] Petitgirard S. et al., 2015. PNAS 112, 14186-14190. [2] Sanchez-Valle C. and Bass J.D., 2010. EPSL 295, 523-530. [3] Ghosh et al., 2014. Am.Min. 99, 1304-1314.