Pressure-induced amorphization in plagioclase feldspars: A time-resolved powder diffraction study during rapid compression

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Impact cratering is important in planetary body formation and evolution [1, 2]. The pressure and temperature conditions during impacts are classified using systems [3-6] that stem from 1) petrographic features and 2) the presence of high pressure mineral phases observed in impactites. Maskelynite, amorphous plagioclase ($(Na_{1-x}\ Ca_x)Al_{1+x}\ Si_{2-x}\ O_8$), is a key indicator of petrographic type S5 [6] (strongly shocked) and forms between 25 and 45 GPa. However, the formation pressure of maskelynite differs substantially depending on the experimental technique producing it. Shock experiments produce amorphization at > 10 GPa higher than static diamond anvil cell (DAC) experiments. We utilize a new technique, fast compression in combination with time-resolved powder diffraction, to study the effect of strain rate on plagioclase amorphization pressure. Anorthite and albite were compressed to 80 GPa at multiple rates from 0.05 GPa/s to 80 GPa/s, and we observed a decrease in amorphization pressure with increasing compression rate for strain rates of about $10^{-3}\ s^{-1}$. This decrease demonstrates negative strain rate sensitivity, which is likely caused by structural defects. Negative strain rate sensitivity implies that faster rates are more ductile and heterogeneous and slower rates are more brittle and homogeneous. Our results fit into the deformation framework proposed by Huffman and Reimold [7] and are consistent with the formation mechanism for maskelynite by "shear melting" proposed by Grady [8].

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