Kingma et al. Reply: The main point of our recent Letter [1] was to report a new high-pressure crystalline-crystalline phase transformation in α-quartz and to remark on its general implications for solid-state amorphization. We further suggested that the elastic anisotropy observed in recovered samples by McNeil and Grimsditch (MG) [2] may originate from undetected crystalline material and that twinning of this residual crystalline phase may account for their reports of elastic sign reversal.

MG claimed in [2] that single-crystal samples recovered from quasihydrostatic compression to 25 GPa are amorphous (the amount of residual crystalline material being <3% [3]). Using a variety of techniques which probe order/disorder at different length scales (including electron diffraction, high-resolution transmission electron microscopy, optical microscopy, and Raman spectroscopy), we found that all quenched samples experiencing maximum pressures of <30 GPa are heterogeneous, having varying proportions of crystalline and amorphous material [1,4]. The use of a single spectroscopic technique (as was done by MG) is insufficient for establishing the degree of amorphization in samples quenched from this pressure. Further, the low signal-to-noise in MG's published Raman spectrum precludes a quantitative analysis (e.g., compare Fig. 2 of Ref. [2] and Fig. 4 of Ref. [1]).

The arguments in MG’s Comment [3] are based on assumptions that the crystalline component of recovered heterogeneous samples is α-quartz and that the glassy component is normal fused SiO₂. We found that neither assumption is correct. In [1], we showed that the Raman peaks originating from the residual crystalline phase in samples recovered from between 21 and 30 GPa are broadened and weakened, some are shifted in wave number, and there are new nonquartz features. The Raman cross sections of the crystalline material and of the densified amorphous silica are not used (nor do they appear to be known). Additionally, we reported distinct nonquartz spots in electron diffraction patterns from the quenched crystalline phase. Thus, the observation of a crystalline-crystalline phase transition and the observed differences between the starting and recovered material show MG’s analysis in [3] to be untenable (i.e., there may be similar deviations in other physical properties, including sound velocities). The recovered crystalline material in these heterogeneous samples, as well as the aggregate itself, must be fully characterized before establishing the degree to which the amorphous component may be anisotropic. The effect of different starting materials (i.e., quartz of varying origin, water content, etc.) and time dependence should also be examined.

We performed over twelve experiments [1,4], consistently producing heterogeneous samples containing complex microstructures with significant long-range order. During these runs, we used the experimental conditions described by MG in [2], taking care to compress our samples quasi-hydrostatically (free of contact with the diamond anvils); it may be possible to explain MG’s observations if residual nonhydrostatic stresses were present in their compression experiments (see Ref. [26] of Ref. [1]). However, we emphasize that without proper sample characterization, the formation of a homogeneous anisotropic amorphous solid produced in these experiments remains, at best, an open question.

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