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Medium-Range Structure in Al-based Amorphous Metals from Fluctuation Electron Microscopy

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High-Al content amorphous metals formed by rapid quenching devitrify to nanometer-sized Al nanocrystals in an amorphous matrix at remarkably high nanocrystal density ($>10^{20} \text{ m}^{-3}$). We have found nanoscale, Al-like order in rapidly quenched amorphous $\text{Al}_{92}\text{Sm}_8$ using fluctuation electron microscopy, a quantitative TEM technique uniquely sensitive to nanoscale order in amorphous materials. This order is not found in $\text{Al}_{92}\text{Sm}_8$ amorphized by mechanical deformation, which also does not devitrify to the nanocrystal / matrix microstructure. The nanoscale order in the rapid-quenched samples is reduced by thermal annealing, suggesting that fluctuation microscopy is measuring sub-critical Al clusters retained during the quench.