Surface nano-topography of matrix olivines in the Allende carbonaceous chondrite: Evidence of shock-wave heating?

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We have proposed new techniques for investigating the fine particles of cosmic materials to reveal its origin and growth conditions of these particles by means of morphology and surface observations. Varieties morphologies of polyhedral fine olivine particles with faceted face have been found in Allende carbonaceous chondrites. Molecular level surface observation of matrix olivine has firstly been succeeded with Atomic Force Microscopy (AFM). Though these fine particles were formed about 4.56 billion years ago, growth steps with mono-molecular height are found to be preserved on its surface. The step pattern suggests that faceted matrix olivines were condensed from gas, and had grown under extensive temperature change within an order of ˜seconds to ˜minutes. This cooling rate agrees with such as shock-wave heating model.