# The future of cosmochemistry: a nanomineralogy approach

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Nanomineralogy is the study of Earth and planetary materials at nanoscales, focused on characterizing nanofeatures (such as inclusions, exsolution, zonation, coatings, pores) in minerals and rocks, and revealing nanominerals and nanoparticles [1,2]. With advanced high-resolution analytical scanning electron microscope, we are now capable to characterize geomaterials easier and faster down to nanoscales. During our ongoing nanomineralogy investigation of meteorites since 2007, more than twenty new minerals have been discovered at micron to nanoscales [3]. 14 of them are from the Allende meteorite, including refractory minerals like panguite, kangite, tistarite, allendeite and hexamolybdenum, which are among the first solids formed in the solar system. Each of the new extraterrestrial minerals reveals distinctive forming environments, providing new insights into nebula or parent-body processes. Around 45 refractory minerals (identified to date) plus about 15 presolar minerals mark the beginning of the solar mineral evolution 4.568 billion years ago. Presented here are a few projects demonstrating how nanomineralogy works and plays a unique role in cosmochemistry research and in preparation for sample return missions.

[1] Ma (2008) *Eos Trans. AGU*, **89**, abs MR12A-01
[2] Ma (2010) *American Mineralogist*, **95**, 188-191
[3] http://www.its.caltech.edu/~chima/