Microscopy TODAY

Coming Events

2012

Testing and Failure Analysis
November 11–15, 2012
Phoenix, AZ
www.asminternational.org/content/Events/ istfa

2012 MRS Fall Meeting
November 26–30, 2012
Boston, MA
www.mrs.org/fall2012

ASCB Annual Meeting
December 15–19, 2012
San Francisco, CA
www.ascb.org

2013

Pittcon 2013
March 17–21, 2013
Philadelphia, PA
www.pittcon.org

Focus on Microscopy 2013
March 24–27, 2013
Maastricht, The Netherlands
www.focusonmicroscopy.org

2013 MRS Spring Meeting
April 1–5, 2013
San Francisco, CA
www.mrs.org/Spring2013

EMAS 2013
May 12–16, 2013
Porto, Portugal
www.emas-web.net

Microscopy & Microanalysis 2013
August 4–8, 2013
Indianapolis, IN
www.microscopy.org

Denver X-ray Conference
August 5–9, 2013
Westminster, CO
www.dxcicdd.com

2014

Microscopy & Microanalysis 2014
August 3–7, 2014
Hartford, CT
www.microscopy.org

2015

Microscopy & Microanalysis 2015
August 2–6, 2015
Portland, OR
www.microscopy.org

2016

Microscopy & Microanalysis 2016
July 24–28, 2016
Columbus, OH
www.microscopy.org

More Meetings and Courses
Check the complete calendar near the back of this magazine and in the MSA journal *Microscopy and Microanalysis*.

Carmichael's Concise Review

This New Mineral is Out of This World!

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In 1969 a meteorite exploded over Pueblito de Allende in northern Mexico. Many of the fragments were recovered and have provided a wealth of information about the chemical composition of our early universe. Most recently, Chi Ma, Oliver Tschauner, John Beckett, George Rossman, and Wenjun Liu have reported a new mineral in one of these meteorite fragments [1]. Ma et al. named this new form of titanium oxide "panguite" for Pan Gu, the giant in Chinese mythology who, in the beginning, created the world by separating the heaven and earth from chaos. This is an allusion to this ultra-refractory mineral, stable at high temperatures and in extreme environments, being among the first solid materials in our solar system.

Panguite is a titanium oxide with the chemical formula $(Ti^{4+},Sc,Al,Mg,Zr,Ca)_{1.8}O_3$. The mineral and its name have been approved by the Commission on New Minerals, Nomenclature, and Classification of the International Mineralogical Association [2]. Ma et al. used a scanning electron microscope (Figure 1) with an electron backscatter diffraction (EBSD) system. The observed EBSD pattern was distinct from those of other forms of titanium oxide and related minerals. Synchrotron micro-Laue diffraction was used to determine crystal structure at a sub-micrometer scale in the *x–y* plane. Panguite was found to be an orthorhombic mineral (that is, having three unequal axes, all at right angles to each other) of space group *Pbca*. Relevant dimensions and geometric features were also determined.

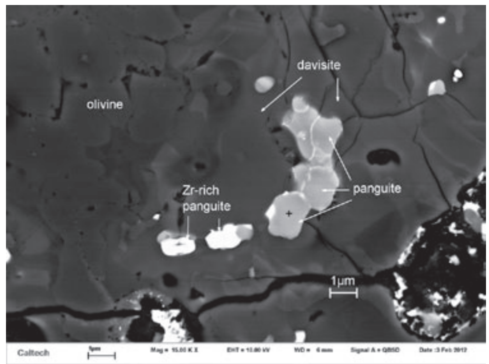

Figure 1: Backscattered electron SEM image showing the panguite phase with smaller Zr-rich panguite regions in davisite.

Although panguite was first detected in the Allende meteorite, Ma and colleagues have found it in several other meteorites of various types, although in very small amounts. They concluded that panguite is a constituent of many carbonaceous chondrites (a group of meteorites that are considered to have formed in the early solar system).

More than thirty oxides, silicates, and minerals are refractory and probably formed in the solar nebula. Panguite is particularly interesting as a potential sensor of the environment in which it was formed. This is because it is a titanium-containing mineral that contains significant concentrations of Al, Sc, and Y, so it should also be able to readily accept large concentrations of Ti^{3+} and heavy earth metals. Certain chemical properties of this Allende panguite strongly suggest that these crystals equilibrated in an oxidizing environment. The minerals identified in the Allende meteorite offer important clues as to the chemical state of our early solar system. Panguite is one of nine new minerals that Chi Ma and colleagues have discovered in the Allende meteorite!

Panguite is not only a new titanium-containing mineral formed in the solar nebula, but also a new material representing unusual chemical and physical features. These characteristics make panguite an interesting candidate for high ion conductivity at elevated temperatures.

References

[1] C Ma, O Tschauner, JR Beckett, GR Rossman, and W Liu, *Am Mineral* 97 (2012) 1219–25.
[2] It is designated IMA 2010-057.
[3] The author gratefully acknowledges Dr. Chi Ma for reviewing this article.

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