CATHODOLUMINESCENCE OF TYPE 3 ORDINARY CHONDRITES. John DeHart and Derek W.G. Sears, Department of Chemistry, University of Arkansas, Fayetteville, AR, 72701.

Introduction. Thermoluminescence (TL) sensitivity has proved of great value in measuring the relative metamorphic intensities experienced by type 3 ordinary chondrites; the parameter displays a 10**3-fold range and is the basis for their division into types 3.0-3.9 (1). There are also systematic changes in the TL peak temperature and width which are related to changes in the TL phosphor and therefore have thermometry and cooling rate possibilities (2). However, for reasons that are unclear, these trends break down for meteorites of type <3.5. In order to better understand these effects, we have examined the cathodoluminescence (CL) of a suite of five ordinary chondrites of type 3, and one each of type 4 and type 6. Since TL and CL processes are strongly related, this enables petrographic examination of the probable TL phosphors.

Methods and Samples. Photomosaics (>1 sq. cm) were prepared of Semarkona (3.0), Krymka (3.0), Bishunpur (3.1), Chainpur (3.4), Ngawi (3.6), Bremervorde (4) and Barwell (6). Particular note was made of the CL of the matrix and chondrules. Here we briefly describe the major trends and conclusions; we hope to publish the photomosaics, in color, in American Scientist.

Descriptions. In Semarkona the CL of the fine-grained matrix is a distinctive, uniform red. Many of the chondrules are non-luminescent, but those that display any CL have a dull to bright blue or yellow mesostasis which encloses crystalline material with dull to bright red CL.

The CL of the Bishunpur matrix is also red; however, it is not uniform, but consists of a number of discrete sources and the amount is very much less than for Semarkona (<15% matrix area). A few point sources of bright blue light (< 3% matrix area) are also noted. The proportion of the chondrules displaying CL is larger, and the variety of responses is greater than in Semarkona. The colour and intensity of the CL of the mesostasis and crystalline material is similar to that found in Semarkona, except there are more bright blue phosphors associated with the chondrules in Bishunpur.

The CL of Krymka is very similar to that of Bishunpur. Where matrix material is identified, the CL response is like that of Bishunpur, except that the amount of red CL is slightly lower. There also appear to be similar proportions of luminescent to non-luminescent chondrules and of luminescent chondrules responding with a dull to bright blue light.

Chainpur appears to have much dimmer and less varied CL response than the previous meteorites. The matrix is non-luminescent, except for many small, widespread points of dull to bright blue light (<10% of matrix area). The principal CL of the chondrules comes from dull to bright blue phosphors in the mesostasis, within which there is crystalline material that is either non-luminescent or dull red. Grains with blue centers and red rims, as described by Steele et al., are also observed (3).

CL of type 3 ordinary chondrites

J.M. DeHart and D.W.G. Sears

Many chondrules also appear to be rimmed by a fine line of yellow phosphor.

The CL properties of Ngawi indicate a highly heterogeneous nature. Blue matrix is abundant, and it is unlike the matrix in the lower types in being much coarser. Often it contains chondrule fragments or grades into chondrule fragments. Noteworthy are two areas with CL similar to Bishunpur and Krymka and very different to the host material; apparently these are primitve clasts (type 3.1) within more metamorphosed material (type 3.6). The chondrules found in Ngawi are highly diverse in their CL. Although the range of colours and intensities are the same as for Semarkona, there appear to be more combinations of luminescent mesostasis and crystalline material. The outlines of many, but proportionally fewer, non-luminescent chondrules are readily seen. Red rims of Semarkona-like matrix material surround some chondrules.

The CL of Bremervorde is a near-uniform blue, both from matrix and chondrule mesostasis. The crystalline material within the chondrules is non-luminescent. A few small, irregular grains with bright red luminescence are also present. Barwell is very similar to Bremervorde in its CL except that structures are generally less well delineated.

Discussion and Conclusions. The CL properties of primitive meteorites are as sensitive to metamorphism as TL, in some senses more so, and several trends are thought to be present. Some of the trends and our conclusions are: 1. At the lowest levels of metmorphism the red CL characteristic of the Semarkona matrix disappears, so that it is rare in type 3.1 and entirely gone by type 3.4; 2. blue phosphors appear in the matrix with increasing petrologic type; 3. the number of non-luminescent chondrules decreases with increasing petrologic type; 4. the ratio of blue CL chondrules to red CL chondrules increases with petrologic type; 5. the matrix of the host material in Ngawi is possibly composed of chondrule fragments; 6. Ngawi contains clasts of primitve (3.1) material in a more highly metamorphosed groundmass, apparently brecciation post-dated metamorphism in Ngawi; 7. on the basis of the CL trends, metamorphism experienced in these meteorites increases along the sequence Semarkona < Krymka = Bishunpur = Ngawi clasts < Chainpur < Ngawi host < Bremervorde < Barwell. It is clear from these studies that the reason why the trends in TL sensitivity vs. peak width and temperature break down below type 3.3 is that at these low levels of luminescence a variety of phosphors are present, while at higher levels the luminescence is produced predominantly by blue phosphors associated with chondrule mesostasis.

1. D.W.G. Sears et al. (1980) Nature 287, 791-795. 2. D.W.G. Sears et al. (1982) Geochim. Cosmochim. Acta 46, 2471-2481. 3. I. Steele et al. (1985) Nature 313, 294-296. (NASA grant NAG 9-81).