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Dr. Donald Crabtree
Dept. of Sociology and Anthropology
University of Idaho
Moscow, ID 83843

Dear Dr. Crabtree:

I am a materials scientist with a strong interest in brittle fracture of glasses and ceramics. As a result of that interest and a general interest in primitive toolmaking technologies, I have learned to chip obsidian and can make a passable arrowhead. I have never worked flint, but I do have some pieces of jasper and other bedded chert that I have tried to work.

It is, apparently, common procedure to heat treat flints before working them, but I am not certain what happens in that heat treatment. From what I have heard, the temperatures are too low to result in crystalline grain growth or to produce a transformation from quartz to tridymite, for example. I assume, then, that what happens is an inversion. If so, I would guess that the heat treatment temperature would be 270°C or so if the crystal form is cristobalite or 570°C if it is quartz.

It is not clear why inversion would make the flint easier to work. My guess here is that the volume change accompanying transformation produces localized strains which tend to make it easier to fracture the material. You may be familiar with recent descriptions of crack propagation in terms of fracture mechanics. In those terms, the fracture toughness, K_{IC}, is apparently reduced by the heat treatment. It would be interesting to measure the fracture toughness of flints before and after heat treatment. It also would be interesting to see if there are any features in the thermal expansion curves of these materials which indicate the development of microcracks.

An alternative possibility is that the material, prior to heat treatment, is not in the stable crystalline form but can be driven to inversion by the stresses at the crack tip. In this case, extra energy, in addition to that needed to produce fracture surfaces, needs to be supplied. However, heat treatment eliminates that need and reduces K_{IC}.

Sandia Laboratories has an interest in developing a class of materials called "glass ceramics". These materials are produced by controlled crystallization of glass and have a microstructure of

very small crystals--in some systems, similar to the cryptocrystalline structure of flint. We would like to know how to make these materials stronger and tougher. I believe that an understanding of the fracture befavior of flints may help in that regard.

That was a long-winded introduction. What I would really like to know is:

1. Do you know of any work that sheds any light on what happens to the flint microstructure during heat treatment?

2. Do you know of any measurements of "fracture toughness" or "fracture surface energy" on these materials?

3. Where is a good source of flint which is not heat treated? (Dimensions of samples for an instrument I have are 0.5 inch diameter by 0.5 inch length.)

4. What heat treatment is required to make flint workable? (Also, for my personal interest in working jasper, can this and other bedded chert materials be heat treated in a similar manner?)

I would greatly appreciate any information you can provide me on these questions.

Sincerely,

Edwin K Beauchamp

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