JPEDAV (2004) 25:306–307
DOI: 10.1361/15477030420250

Editorial

I am presently engaged in teaching a course called "Microstructure of Materials" to second-year university undergraduates. As part of this course, I need to explain the use of phase diagrams and about the relationship between phase diagrams and heat treatment, and in doing so I try to stimulate the students' interest by using materials that are familiar to them from everyday life. For example, I explain why it is impossible to cook delicious rice at high elevations due to the drop in the boiling point of water through the use of a pressure-temperature (PT) diagram. Also, I teach the concept of binary phase diagrams in terms of the process for manufacturing clear ice, using phase diagrams for water and air, following the textbook of Ashby and Jones.[1]

Quite recently, a eutectic-type phase diagram of milk and chocolate binary system has been presented,[2] and this too is an example of the use of everyday materials. With regard to heat treatment in relation to equilibrium phase diagrams, as well as metastable phase diagrams, I use the example of water and alcohol. Figure 1 shows the phase diagram for water and ethanol, and the dotted line indicates the metastable phase boundary.[3] However, thermal analysis of the water-ethanol system shows several peaks that are not explained by the phase diagrams and that suggest the existence of pentakaidecahedral cage.[4]

Similar complex peaks caused by metastable phases have been reported in commercially available whiskeys.[5] The thermal analysis curve for chilled whiskey is given in Fig. 2. The broken line is the differential scanning calorimetry (DSC) curve for the whiskey the first time it is cooled. The exothermic peak is observed to begin at −39 °C (–38 °F) (this corresponds to the primary crystallization from the liquid in Fig. 1) and is observed again at −52 °C (–62 °F). However, this latter finding cannot be explained in terms of the phase diagrams, so the peak here is referred to as "peak X." The solid line in Fig. 2 illustrates the DSC curve when this same whiskey is cooled a second time. You will note that there is a significant difference in the size of the peak at −55 °C (–67 °F), and it is reported that this phenomenon occurs with all brands and types of whiskey.[5] What is truly surprising is that whiskey that has been chilled twice is said to be far more delicious than the same whiskey when it has been chilled only once, and moreover, it is said that the mellowness of the flavor depends on the height of the X peak.[5] It appears that a metastable phase develops that transforms an ordinary whiskey into a high-class brand. I might suggest that the next time you buy a cheap whiskey, don't drink it right away. Try aging it in your freezer first!

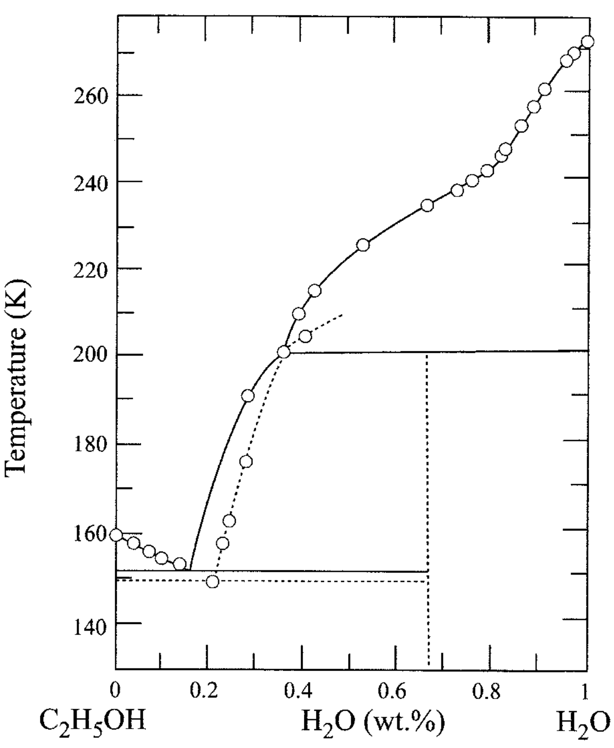

Fig. 1 Phase diagram of the ethanol-water system

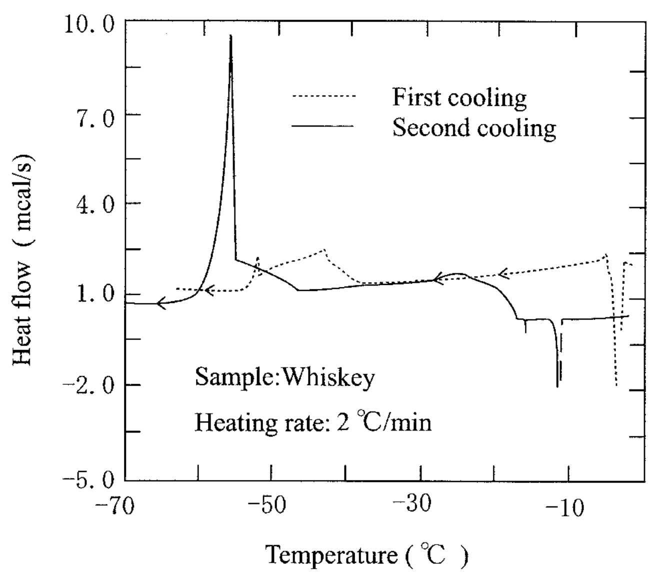

Fig. 2 DSC curve of whiskey

References

1. M.F. Ashby and D.R.H Jones: *Engineering Materials 2, An Introduction to Microstructures, Processing and Design,* Pergamon Press, 1986, p. 39.
2. *Adv. Mater. Process.,* Jan 2004, p. 79.
3. J.B. Ott et al.: *J. Chem. Thermodyn.,* 1979, *11,* p. 739.
4. P. Boutron and A. Kaufman: *J. Chem. Phys.,* 1978, *68,* p. 5032.
5. K. Ehara and A. Maezono: *Kinzoku,* Dec 1994, p. 11 (in Japanese).

Kiyohito Ishida
Associate Editor
Journal of Phase Equilibria and Diffusion