



	Experiment title: Liquid and solid bismuth under pressure: undercooling and polymorphism	Experiment number: HS2725
Beamline: BM29	Date of experiment: from: 13 March 2005 to: 24 March 2005	Date of report: 03 August 2006
Shifts: 27	Local contact(s): Simone De Panfilis	<i>Received at ESRF:</i>
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Report:

The results of the experiment HS2725 have been reported in the paper "Metastable phase diagram of Bi probed by single energy x-ray absorption detection and angular dispersive x-ray diffraction" PHYSICAL REVIEW B 74, 064101 (2006).

The abstract and references of this paper follow below.

Abstract:

In this paper we report the results of a detailed experimental study of samples composed of micrometric Bi droplets providing an insight into the metastable phase diagram of Bi. To this purpose we have used the single-energy x-ray absorption detection technique in combination with angular dispersive x-ray diffraction available at the BM29 beamline of the European Synchrotron Radiation Facility. This unconventional approach has given proof of being a different and reliable tool for detecting subtle structural modifications in condensed matter. The investigation has revealed a large variety of metastable Bi polymorphs in a broad range of pressures and temperatures (25-500 C, 0-6 GPa) and the occurrence of a Bi crystalline structure isomorphic to the beta-tin structure. We have shown that the range of undercooling of liquid Bi strongly depends upon pressure and the underlying solid stable and metastable phases. As a final result a Bi-phase diagram including metastable phases is proposed, which takes into account all structural information obtained from this experiment.

- 1) F. P. Bundy, Phys. Rev. 110, 314 1958 .
- 2) W. Klement, Jr., A. Jayaraman, and G. C. Kennedy, Phys. Rev. 131, 632 1963 .
- 3) S. Nichols, J. Phys. D 5, 799 1972 . 4) S. Nichols, J. Phys. D 5, 1898 1972 .
- 5) H. Iwasaki, J. H. Chen, and T. Kikegawa, Rev. Sci. Instrum. 66, 1388 1995 .
- 6) J. H. Chen, H. Iwasaki, and T. Kikegawa, High Press. Res. 15, 143 1996 .
- 7) J. H. Chen, H. Iwasaki, and T. Kikegawa, J. Phys. Chem. Solids 58, 247 1997 .
- 8) J. H. Chen, T. Kikegawa, O. Shimomura, and H. Iwasaki, J. Synchrotron Radiat. 4, 21 1997 .
- 9) A. Di Cicco, L. Comez, J.-P. Iti, and A. Polian, in AIRAPT-17 Proceedings, Honolulu, Hawaii, 2000, edited by M. H. Manghnani, W. J. Nellis, and M. F. Nicol, p. 452.
- 10) M. I. McMahon, O. Degtyareva, and R. J. Nelmes, Phys. Rev. Lett. 85, 4896 2000 .
- 11) K. Tsuji, J. Non-Cryst. Solids 117 118, 27 1990 .
- 12) D. A. Young, Phase Diagrams of the Elements University of California Press, Berkeley, CA, 1991 .
- 13) Y. Katayama and K. Tsuji, J. Phys.: Condens. Matter 15, 6085 2003 .
- 14) K. Yaoita, K. Tsuji, Y. Katayama, M. Imai, and J.-Q. Chen, J. Non-Cryst. Solids 150, 25 1992 .
- 15) Y. Waseda, The Structure of Non-Crystalline Materials McGraw- Hill, New York, 1980 .
- 16) N. Jakse, L. Hennet, D. Price, S. Krishnan, T. Key, E. Artacho, B. Glorieux, A. Pasurel, and M.-L. Saboungi, Appl. Phys. Lett. 83, 4734 2003 .
- 17) C. A. Angell and S. Borick, J. Phys.: Condens. Matter 11, 8163 1999 .
- 18) S. Ansell, S. Krishnan, J. J. Felten, and D. L. Price, J. Phys.: Condens. Matter 10, L73 1999 .
- 19) V. V. Brazhkin and A. G. Lyapin, J. Phys.: Condens. Matter 15, 6059 2003 .
- 20) W. B. Holzapfel, Rep. Prog. Phys. 59, 29 1996 . 21) H. Tanaka, Phys. Rev. B 66, 064202 2002 .
- 22) V. V. Brazhkin, S. V. Popova, and R. N. Voloshin, High Press. Res. 15, 267 1997 .
- 23) E. Rapoport, J. Chem. Phys. 46, 2891 1967 . 24) L. I. Aptekar, Sov. Phys. Dokl. 24, 993 1979 .
- 25) E. G. Ponyatovsky, J. Phys.: Condens. Matter 15, 6123 2003 . 26) Y. Katayama, T. Mizutani, W. Utsumi, O. Shimomura, M. Yamakata, and K. Funakoshi, Nature London 403, 170 2000 .
- 27) A. Filipponi, M. Borowski, D. T. Bowron, S. Ansell, A. Di Cicco, S. De Panfilis, and J.-P. Iti, Rev. Sci. Instrum. 71, 2422 2000 .
- 28) A. Filipponi, V. M. Giordano, S. D. Panfilis, A. Di Cicco, E. Principi, A. Trapananti, M. Borowski, and J.-P. Iti, Rev. Sci. Instrum. 74, 2654 2003 .
- 29) G. Aquilanti, W. Crichton, and S. Pascarelli, High Press. Res. 23, 301 2003 . 30) J. M. Besson, R. J. Nelmes, G. Hamel, J. S. Loveday, G. Weill, and S. Hull, Physica B 180 & 181, 907 1992 .
- 31) L. G. Khvostantsev, V. N. Slesarev, and V. V. Brazhkin, High Press. Res. 24, 371 2004 .
- 32) L. Ottaviano, A. Filipponi, and A. Di Cicco, Phys. Rev. B 49, 11749 1994 .
- 33) A. Filipponi, M. Borowski, P. W. Loeffen, S. De Panfilis, A. Di Cicco, F. Sperandini, M. Minicucci, and M. Giorgetti, J. Phys.: Condens. Matter 10, 235 1998 .
- 34) A. Filipponi, A. Di Cicco, and S. De Panfilis, Phys. Rev. Lett. 83, 560 1999 .
- 35) R. M. Brugger, R. B. Bennion, and T. G. Worlton, Phys. Lett. 24A, 714 1967 .
- 36) E. Y. Tonkov, High Pressure Phase Transformations, A Handbook Gordon and Breach Science Publishers, New York, 1992 , Vol. 1. 37) D. Decker, J. Jorgensen, and R. Young, High Temp. - High Press. 7, 331 1975 .
- 38) J. L. Plissier and N. Wetta, Physica A 289, 459 2001 . 39) D. Turnbull, in Undercooled Alloy Phases, edited by E. W. Collings and C. C. Koch Metallurgical Society, Warrandale, PA, 1987 .
- 40) W. Yoon, J. S. Paik, D. LaCourt, and J. H. Perepezko, J. Appl. Phys. 60, 3489 1986 .
- 41) J. F. Cannon, J. Phys. Chem. Ref. Data 3, 781 1974 .