Kinetics of Bi2223 phase formation in Ag tapes with modified precursor powders

X.-P. Yang[1,2], J.-C. Grivel[1], A.B. Abrahamsen[1], Z. Han[2], W.-Z. Zhang[2] and M. von Zimmermann[3]

[1]Risø DTU, Technical University of Denmark, Frederiksborgvej 399, 4000 Roskilde, Denmark

[2]Applied Superconductivity Research Center, Tsinghua University, 100084 Beijing, China

[3]HASYLAB at DESY, Notkestrasse 85, 22603 Hamburg, Germany

The high-temperature superconductor $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10}$ (Bi2223) is one of the few materials exhibiting performances that are suitable for large scale power applications. Its manufacture in form of flexible wires or tapes suited for the design of cables, requires a metal sheath in order to stabilise mechanically the thin strands of superconducting ceramic. In the production process known as "power-in-tube", a mixture of precursor powders is packed into a Ag tube, which is then mechanically deformed to the required dimensions. In principle, the precursor powders do not consist in Bi2223 but in a mixture of other phases instead. After deformation of the metal/precursor powders composite, the wire/tape is heat treated at high temperature in order to convert the precursor phases into Bi2223. The conversion is however not complete in a single heat treatment and the complete process involves an additional high temperature treatment following an intermediate mechanical densification process. In order to speed up the conversion process, it has been proposed to add a small amount of pre-reacted Bi2223 grains as seeds in the precursor powders [1-3]. During the present project, the incidence of such seeds on the Bi2223 phase formation mechanism has been studied *in-situ* on 4 tapes containing various amounts of Bi2223 seeds.

The present studies were performed at beamline BW5 with a 77keV incident beam. The samples (3cm long tapes) were placed in a furnace with a flow of 8.5% oxygen – 91.5% Ar. After an initial fast heating to 450°C, the tapes were heated to 830°C at a rate of 100°C/min with an intermediate 2h dwell at 765°C. Details on the data analysis process will be published elsewhere [4].

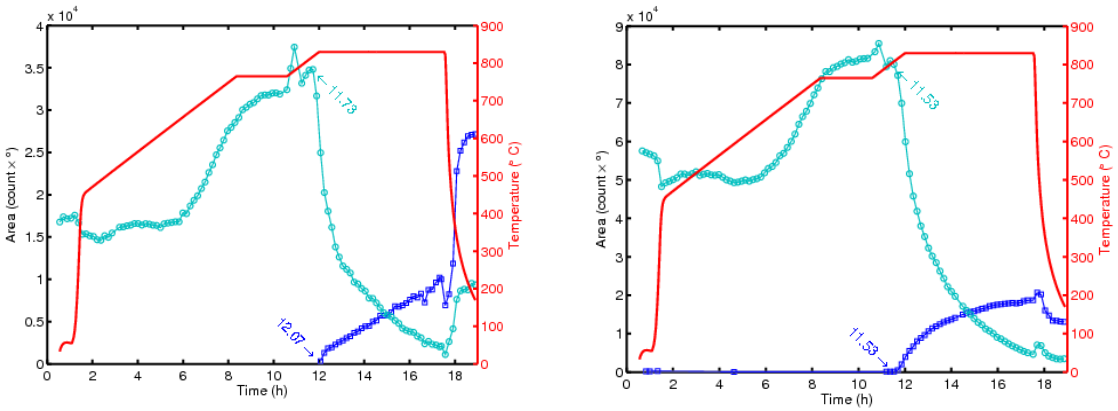

Figure 1: Time evolution of the $Bi_2Sr_2CaCu_2O_8$ (cyan) and Bi2223 (blue) volume fractions in tapes with standard precursor powders (left) or 3% Bi2223 (right).

As shown in Fig.1 for a standard tape (no Bi2223) and a tape containing an initial amount of 3% Bi2223, the time dependence of the Bi2223 fraction exhibits a different shape in Bi2223 seeded tapes. Analysing the time dependence of the Bi2223 volume fraction by means of the Avrami relation, we could evidence that Bi2223 particles in the precursor powders actually suppress the initial nucleation stage and modify the formation mechanism towards a pure plate growth process. Higher initial amounts of Bi2223 further enhance the contribution of plate-shaped Bi2223

crystallites thickening as the more numerous Bi2223 seeds result in an early impingement of growing grains [4].

References

[1] W.J. Kim, H.G. Lee, S.C. Kwon, K.B. Kim, H.J. Lee and G.W. Hong, Supercond. Sci. Technol **12**, 97 (1999).

[2] Y. Nakamura, N. Torii, R. Inada and A, Oota, Supercond. Sci. Technol. **21** (2008) 035001

[3] J.-C. Grivel, X.P. Yang, A.B. Abrahamsen, Z. Han, N.H. Andersen and M. von Zimmermann, J. Phys. Conf. Ser.: accepted

[4] X-P. Yang, J.-C. Grivel, A.B. Abrahamsen, Z. Han, W.-Z. Zhang and M. von Zimmermann, Submitted to Supercond. Sci. Technol.