Synchrotron radiation techniques for the characterization of Nb_3Sn superconductors

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The performance of synchrotron sources and insertion devices has continuously improved in recent years. The high flux of high energy x-rays that can now be provided through high energy beam lines has enabled a variety of new experiments with the highly absorbing Nb_3Sn composite superconductors. Due the high x-ray flux, which exceeds the neutron flux of the most powerful neutron sources by many orders of magnitude, synchrotron experiments can be very fast and only a small sample volume is needed. In addition, the relatively small scattering angles of high energy x-rays make it easier to add auxiliary equipment, such as a furnace, tensile rig or cryostat, to the experiment in order to perform experiments *in-situ*. Different synchrotron techniques can be combined in one experiment, e.g. diffraction and micro-tomography during *in-situ* heat treatment.

We report different experiments with Nb_3Sn strands, which have been conducted at the ID15 high energy scattering beam line of the European Synchrotron Radiation Facility (ESRF). Synchrotron x-ray diffraction has been used in order to monitor phase transformations during *in-situ* reaction heat treatments prior to Nb_3Sn formation, and to monitor Nb_3Sn growth. The phase transformations that occur in Nb_3Sn strands with strongly differing overall elemental composition are compared. Fast synchrotron micro-tomography was applied to study void growth during the reaction heat treatment of Internal Tin strands. The elastic strain in the different phases of fully reacted Nb_3Sn composite conductors can be measured by high resolution x-ray diffraction during *in-situ* tensile tests.