1ST Year Report- Hafiz Mansoor ul Hassan

Study and development of Ba_122 superconductor for Applications.

My PhD thesis is funded by the PNRR - Research Infrastructure (Missione 4, Componente 2) Project "IRIS – Innovative research Infrastructure on Applied Superconductivity" and it is devoted to "Study and development of Ba_122 superconductor for Applications". The activity is done at the Institute CNR_SPIN and it is done within the Work Package 3 in collaboration with DIFI and INFN. Moreover the activity on Ba122 superconductors is in the framework of a collaboration agreement between CNR.-SPIN and CERN for the development of Iron Based superconductor for high magnetic field applications.

Iron Based Superconductors (IBS) since their discovery in 2008 have grown to become a new class of high magnetic field superconductors. At low temperature, their upper critical fields are high up to 60T, proving that they are very promising for fusion magnets and accelerators. IBS explore a new area for basic theoretical research as well as potential applications under high magnetic fields. Despite the commonalities between these high temperature superconductors, IBS exhibit a different pairing symmetry, a smaller anisotropy parameter, better grain boundary transparency. Providing both challenges and opportunities for practical applications. So far, the long-length BaK122 superconducting wires have been fabricated by the cost-effective powder-in-tube (PIT) method. There are different IBS families, each deriving from a common parent material. $KBaAs_2Fe_2$ (so-called 122 family) is very interesting because of its properties.

My PhD thesis is included in a collaboration agreement between CERN and CNR-SPIN. The objective of this agreement is the fabrication of multifilamentary wires realized with the powder in tube (PIT) method with Jc at least 105 A/cm2 at 16T at the temperature of interest.

The aim of my project is to develop Ba_122 superconducting wires realized with the powder in tube (PIT) method The PIT method consists of tube filling, drawing and heat treatment. Superconducting powder filled inside the metal tube. The filled tube is then subjected to a drawing or extrusion process. This involves reducing the diameter of the tube and simultaneously elongating it. Then heat-treated to enhance its superconducting characteristics.

Experiments performed:

My first year of PhD will be mostly focused on the preparation of optimized Ba122 phase in terms of purity (free impurities) homogeneity, and optimized critical field and critical temperature. In the three months of work since my arrival in Italy I focused on the study of K. Potassium K is very volatile material so we don't know during process how much we loss K and how much remaining that's why we need the access amount of potassium to produce Ba_122 powder.

In this point of view we prepared 5 different batches of 2g powder of Ba_122 with access of Potassium of 20%, 15%, 10%, 5% and 00% in [K=0.0870g, Ba=0.4583g, As=0.8335g and Fe=0.6212].So required grams of material (K, As, Ba and Fe) are mixed together homogeneously with the help of Ball milling process at 650 rpm for 15 and 15 hours in Glove Box. Transfer this powder into niobium tube with a diameter of 10 mm and pinch both sides put this tube into steel crusible diameter of 15 mm and weld both sides carefully. After welding the steel container containing the niobium crucible and the precursors, it is placed inside the oscillating furnace with a ramp of 50°C per hour up to 750°C for 50 hours. Then granding powder with help of Agate Mortar. And analyzed its XRD measurement, SEM measurements and SQUID measurements. And results are in progress to see the access of K is batter or not.

On the other hand I took experiences in different performses like using glove box, Operating XRD and learn SOP's regarding Different instruments (Rolling Machines, Furnaces, Cutting and welding) in SPIN.

Supervisors:

- Andrea Malagoli (CNR-SPIN)
- Marina PUTTI (Università degli Studi di Genova)

Course attended:

- Design of Superconducting Magnets

- Applied Cryogenics
- Technology of wires, tapes and superconducting cables

I plan on taking “applied cryogenics” and “Design of Superconducting Magnets” in the end of February and “Technology of wires, tapes and superconducting cables” in March.

Conferences attended:

- EUCAS 2023, 3-7 September 2023

Short Courses:

- “Materials” in EUCAS 2023, 3-7 September 2023