Epoch Wires Ltd has developed and patented the prototype for a novel method of producing infinitely long cost effective Magnesium Diboride (MgB₂) superconductive wires for applications in magnetic resonance imaging (MRI), power generation, power distribution and power storage. The process has the capability to produce infinitely long MgB₂ superconductive wires with a high core ratio, enabled through our novel in-line nanoparticle feeding system and laser-seam welding technology.

**PROCESS**

A bimetallic strip consisting of copper and steel is used to achieve a combination of high densification and good internal stabilisation. This design allows for compression and high powder densification due to the outer process performance. Trapped humidity and excessive oxygen in powders are removed in a high temperature purpose-designed mixers under protective atmosphere to improve sinterability and critical current.

**POWDER PURIFICATION & MIXING**

In-situ powders magnesium and boron are purified and mixed with copper and nano-doping agents in purpose-designed mixers under protective atmosphere to improve sinterability and critical current performance. Trapped humidity and excessive oxygen in powders are removed in a high temperature vacuum environment. The process produces a homogeneously mixed blend ready for the production (see figs. 1, 2 & 3).

**FLOW CHART**

![Flow Chart Image]

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**NANO POWDER FEEDERS**

Epoch Wires have designed a series of nano powder feeders, which are capable of feeding nano powders with high accuracy to continuously fed U profile. The adjustability of multiple nano-powder feeders control the fill ratio and generate an opportunity to feed a mixture of ex-situ and in-situ powders to the same core. The results confirm that the powder mixed within the U profile is highly homogenous (figs. 4, 5, 6).

**LASER-SMAM WELDING**

The U profile filled with nano powder mix is sealed and subsequently laser-seam welded. The positioning of the laser beam, laser power, the distance from the laser source to the wire and laser beam size are optimised making sure that the weld joint is mechanically sound and suitable for further deformation. In addition, the laser welding is finely tuned ensuring that the penetration of laser beam is held at the steel/copper interface to minimise the risk of copper embrittlement in the weldment (figs. 7, 8 & 9).

**MICRO-ROLLING & IN-LINE HEAT TREATMENT**

Laser-seam welded wire is rolled using a series of mini rollers and the diameter is reduced down to 0.8mm. The micro-rolling process creates heavily compacted and densified core. The core density of the wire reaches 89% theoretical density of MgB₂ after the rolling process. The final structure of the wire consists of elongated Mg fibres along the rolling direction encapsulated with nano boron powder. The final wire is subsequently chemically cleaned and heat treated in-line (figs. 10, 11, 12 & 13).

**CRITICAL TEMPERATURE & CRITICAL CURRENT MEASUREMENTS**

Initial measurements in stainless steel sheathed wire indicated that the Tc is approximately 37K (fig. 13) which is 2K lower than Tc of MgB₂, reported in the literature. This could be due to the presence of copper substitution in the core powder and also due to the presence of some other impurities. Initial critical current characterisation using electric field criterion E=0.1 V/cm at liquid nitrogen temperature revealed potential for future cost effective conductors for large-scale applications.

**SUMMARY**

Initial tests carried out on prototype wires manufactured using infinitely long wire manufacturing technology revealed potential for future cost effective conductors for large-scale applications.