Conductors from Superconductors

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Abstract - Kamerlingh Onnes came to Chicago in 1913, just two years after discovering superconductivity, with a detailed plan to make a 10 T superconducting magnet! He recognized very clearly the central advantage of superconductors for generating strong magnetic fields – their ability to make compact windings operating at current densities of many hundred A/mm^2 without dissipation. His Hg wires passed 1000 A/mm^2 – but sadly only in self-field, and the dream was put away. Fifty years of confusion over the distinction between positive and negative surface energy superconductors ensued that was blown away only in 1961 when, to great surprise, Nb_3Sn was found to superconduct while carrying 1000 A/mm^2 at almost 9 T. Within 2 years, Onnes's dream was fulfilled and, within 10 years, Nb-Ti and Nb_3Sn research superconducting magnets became common, based on sub-divided conductors composed of fine, twisted and decoupled superconducting filaments. At first for science, above all for accelerators, magnet applications pulled the technology powerfully and then in the late 1970's MRI emerged as the anchor of the superconducting wire industry. Today a profitable industry making NbTi and Nb_3Sn conductors exists on multiple continents. MgB_2, $REBa_2Cu_3O_{7-x}$ and the two BSCCO compounds, $Bi_2Sr_2CaCu_2O_{8-x}$ and $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10-x}$ are vying to add to the mix. Some interesting stories of how this technology emerged and how it might still change will be presented to remind us that progress is never smooth and steady, but rather episodic and sometimes disruptive.

Keywords - Low- and high-temperature superconductors, technical superconducting wires, critical currents and critical fields, superconducting magnets, LHC

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