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A quarter century of excellence in high-temperature superconductivity

THEVA has always been pursuing own innovative concepts and celebrates anniversary

THEVA celebrates its 25th anniversary this summer. Founded as an early spin-off of the Technical University of Munich in 1996, today THEVA is one of the longest-standing and most successful companies active in the field of high-temperature superconductors (HTS). The company has established itself as the only European manufacturer of high-quality HTS wire and coils for magnet technology and electrical engineering. Far beyond materials manufacturing, THEVA is also actively promoting the use of superconductors for the climate-friendly transformation of energy technology.

It all began in 1996 with the large-area HTS coating of crystalline substrates, so-called wafers, using PVD coating systems developed specifically for this purpose. Wafer coating was important for electronic applications, especially in the field of high frequency, and the world record of 8" wafer diameter achieved at that time is yet unbroken. Today, this business field is successfully continued by Ceraco, which was spun off from THEVA in 2012.

As early as 1998, THEVA began to develop and adapt vacuum evaporation also for reel-to-reel coating of flexible metal tapes, now known as 2G HTS tape or coated conductors. For the processing, completely proprietary concepts were developed, far away from beaten tracks, e.g. for the formation of crystalline orientation (through buffer layers), for the HTS deposition, and also for metallization, which renders coated conductors usable for applications.

It is in the DNA of this company to find its own path. While most others jumped on mainstream techniques such as RABiTS or IBAD, THEVA managed to establish a proprietary, independent manufacturing route and to protect it with patents. The process technology developed is characterized by the elimination of complexity in the individual steps, excellent scalability, and the potential for automation to the greatest possible extent. This results in cost advantages that are crucial for the economic production of a future commodity product.

No less important was the parallel development of customized plant technology for coating as well as measuring equipment for quality monitoring. For the latter, nothing was available on the market at the beginning. In this situation, THEVA developed the TAPESTAR™ to measure current carrying capacity and superconducting properties with high spatial resolution. The device became an absolute success story, as it is now used for quality control by virtually all HTS conductor manufacturers worldwide.

A decisive milestone on the way to commercialization was reached in 2012, when the first two VC funds were won as investors. This was accompanied by generous project funding from the German Federal Ministry for Economic Affairs and Energy (BMWi). In the years that followed, the findings from the laboratory were transferred to an industry-oriented pilot production facility, which still represents the core of THEVA's HTS tape production today.

Last year, this proved that 2G HTS tape with record current-carrying capacity of up to 1000 A/cm can be manufactured largely automatically and with high yield in an industrial production environment. This year, after two years of intensive development, THEVA was able to add another new HTS conductor type to its Pro-Line product group. By incorporating non-superconducting nanoparticles (artificial pinning), the performance in magnetic field was once again more than doubled.

The material with artificial pinning formula, specifically designed for high-field applications, achieves unparalleled current densities of 800+ A/mm^2 at 20 K, 20 T, which were previously considered impossible. This conductor thus surpasses all classical superconductors and competing high-

temperature superconductors (such as 1G HTS wire) which opens up completely new perspectives for the realization and use of high magnetic fields in research and technology.

Beyond manufacturing technology and quality assurance, THEVA has been actively promoting the development of superconductor technology applications for several years. For example, the world's first HTS wind generator was realized and operated on a wind turbine on the Danish coast within a European consortium (EcoSwing). Thus, for the first time, wind energy was generated with the help of superconductors and fed into a public grid. The magnet system for an inductive heater for heating aluminum billets has just been completed – a further advancement (now based on 2G wire) of the heater concept of the former Zenergy / Bültmann collaboration, which has won many awards for its energy efficiency.

The SuperLink project is currently being designed and prepared for the construction of the world's longest and strongest superconductor cable route with a supply contract in the urban grid of the Munich municipal utility. In contrast to many other projects, the Munich cable will not be designed for medium but for high voltage (110 kV) and can thus transport more than half a gigawatt of electrical power. In terms of projected length, i.e. 12-15 km in the final expansion stage, the cable is also unparalleled and at the top of the international competition. This means that SuperLink will be a real landmark project and the cable will become the flagship for the widespread use of HTS cables worldwide.

Even today, superconductors are mainly used in magnet technology to generate high fields. In this sector, cooling is not regarded an entry hurdle, HTS wires are offering unbeatable performance advantages, and magnets with 30+ T are within reach.

However, the future will belong to power engineering and the signs are set for go. The dramatic effects of the climate change and the growing awareness of the need for an energy transition, away from fossil energy production, towards renewable sources and electrical energy is just creating a second wave of electrification. This sets the stage for superconductivity, which can score with unparalleled advantages wherever high electrical currents and power are needed.

In this context, THEVA is now planning to expand its production capacities to overcome the remaining major hurdle, the massive reduction of costs and market penetration.

35 years after its discovery by Müller and Bednorz, HTS are on the verge of becoming an essential building block of our future energy system and are thus finally beginning to deliver on the promise of efficient energy supply. THEVA is particularly fortunate that Nobel Laureate Dr. Georg Bednorz has accompanied its path for years in a benevolent and advisory capacity.

THEVA is marking its 25th anniversary by offering all HTS tapes on its stock list at a 25% discount until the end of this year. The current stock list can be requested at info@theva.com.