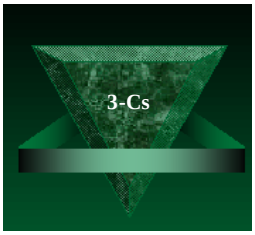

Milestones on the road to coated conductor cylinders and their applications.

E.F. Maher, 3-Cs Ltd. (formerly Coated Conductor Cylinders Limited) Malvern, UK.

Coated conductor cylinders with patterned multilayers of superconducting and insulating thin films were proposed as far back as 2001 as an alternative approach to a new generation of superconducting electrical machines with unrivalled power density. Successful feasibility studies, mostly on demonstrations of the fabrication of multilayers on curved rotating surfaces at the University of Birmingham, were published in subsequent years, but until recently the 3-Cs concepts received little attention from systems designers.

As the limitations of coated conductor tape became more clear – the economics, the handling difficulties etc - other groups started working on the more robust cylinder approach with specific applications in mind. The topic has reached a stage of maturity where informed debate and consideration by system designers will benefit the HTS community. The advantages of the alternative cylinder approach extend far beyond economic factors – benefits include higher power density, reduced size and weight, increased structural integrity, better thermal management, sharper dynamic characteristics and even reduced AC losses.

Using the 3-Cs approach, the absence of any physical winding processes during coil fabrication is in stark contrast to the case of coated conductor tapes, which have to be spooled many times during manufacture and then subsequently wound into coils. The economics of the inherently robust 3-Cs approach will likely follow the example of the semiconductor device industry rather than the traditional wire manufacture and coil winding approaches used for over 100 years in electrical machine manufacture.

Major Milestones :

2001 : Coated conductor cylinder concept - novel coil fabrication patent application. Research Agreement reached with the University of Birmingham re collaborative feasibility studies for patent substantiation.

2002 : Initial feasibility studies successful for deposition of multiple YBCO and multiple buffer layers on curved surfaces at the University of B'ham. Transfer of texture verified, using XRD and EBSD.

2003 : Further patent application re new approaches to defect management, in-situ testing and adaptive features during manufacture. First public presentation of original 3-Cs concepts at CCA2003, and EUCAS 2003.

2004 : Superconducting Week article, and first paper on 3-Cs cylinders as an alternative approach published in SUST (Journal of Superconducting Science and Technology). Also presented at ASC2004.

2005 : First significant equity finance obtained, laboratory space acquired, equipment purchased and team extended. Further patent applications filed. Los Alamos multilayer results support the 3-Cs concepts.

2006 : Initial texturing studies successful – and first scale-up attempts of Inclined Substrate Deposition on a rotating cylinder. Feasibility studies on buffer layer choices accepted for publication in SUST.

2007 : Scale-up of buffer layer depositions on rotating cylinders. Inductive shield demonstrator. Multilayer feasibility studies on curved surfaces at B'ham reach 15 layers on a RABiTS substrate – published in SUST.

2008 : First 3-Cs patents proceed to grant - UK and China. Further significant finance raised. Design of cylinder processing equipment enables several deposition techniques in one chamber. High power Excimer laser arrives.

2009 : "Test patent" accepted by the European Patent Office. Pilot plant facility installed and commissioned, and now in operation – ***see P.J Hirst et Al, poster session P-364, Thursday Sept 17th 9:30-11:00, EUCAS2009***.

What next? 2010 and beyond : Co-development projects in selected applications with major players. 3-Cs cylinders developed for a range of demonstrators – eg E-M shields for sensors and FCL devices, first lithographed lightweight transformers for defence/aerospace, magnetic modules for a novel HTS MRI magnet, etc. etc.

Acknowledgements : The author wishes to thank Prof. Stuart Abell and Prof. Tim Button of the University of B'ham, and their co-workers, especially Dr. Carol Cheung, for conducting feasibility studies to substantiate the 3-Cs concepts. Thanks are also due to the 3-Cs Ltd. team – Dr. Phil Hirst, Brian Baker, Graham Monnington and Dr. Liang Tian for their continued efforts and successes in scale-up issues and process developments. Thanks also to the support given by Advantage West Midlands, Life-IC, and the DTI in numerous grants over the last few years.