VIDEO ARTICLE

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Filtered Cathodic Vacuum Arc: Evolution beyond Coating Materials

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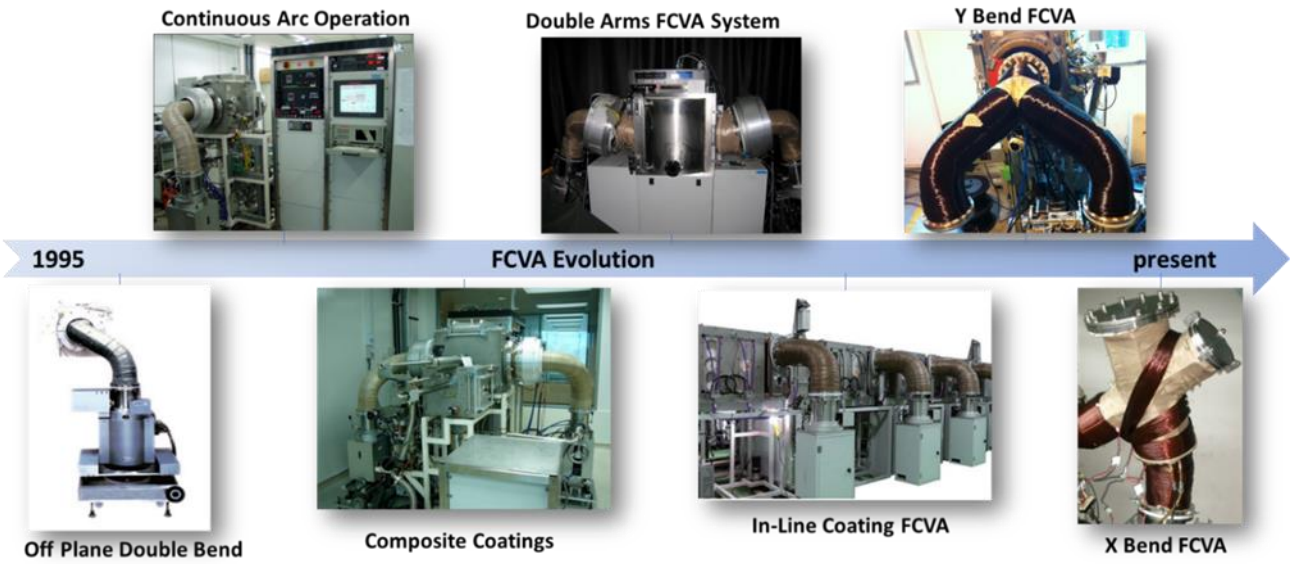
Graphical Abstract



Abstract

The arc process to produce plasma from solid targets was first discovered by Thomas Edison for thin film deposition. The arc process soon developed into the cathodic vacuum arc system when it was invented in the 1960s. In the 1970s, the filtered cathodic vacuum arc (FCVA) was born. The FCVA technology enables vacuum coating deposition to be performed at room temperature, which is both environmentally friendlier and allows vacuum coating to be performed on a wider variety of substrate materials such as plastics, rubber and ceramics. The ability to filter ionized particles and, more importantly, to control the highly ionized plasma to alter the energy of the deposition ions has open up to a new era of nanomaterials. This talk aims to give an insight on the breakthrough from a conventional FCVA technique and showcase the evolution, development and applications of an industrial proven FCVA. The technological evolution from a single 90° filtering bend to an off-plane double bend (OPDB) filtering, from a single composite target source to a dual target source Y-bend FCVA, from batch loading to continuous in-line FCVA deposition, will be presented. We have also seen the development from hard coatings in the first unique monolithic tetrahedrally-bonded hydrogen-free coatings (ta-C) which was deposited by FCVA more than 20 years ago to carbon hybrid

composite films with increasing industry and research applications. These applications range from wear resist tribological coatings in small simple razor blades and hard-disk slider to large complex automotive parts and multi-functional printer parts. FCVA is also able to deposit other forms of thin films such as nano-crystalline graphitic (NCG) for electronics and thermal applications, metal oxide film for UV photoluminescence, waveguides and distributed bragg reflectors (DBR) and nanocomposite films for change in film hydrophobicity and electrical resistivity. Exploration was also made to embed metal catalyst in carbon thin film that can be used for Carbon Nanotubes growth. The technological development of FCVA over the years has significantly grown from laboratory-based research into an industry proven functional products.

Keywords: Carbon based materials, filtered cathodic vacuum arc, ta-C, nanocomposite film, plasma.

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References

More Information can be found on the first author's website and Nanofilm website.

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Biography of Presenting Author

Beng Kang Tay is a full professor in Nanyang Technological University (NTU), Singapore. He is a pioneer in Filtered Catholic Vacuum Arc (FCVA) technology and works for many years in the development of thin film deposition and applications, especially in functional amorphous carbon, nanocomposites and novel van der Waals films. His current research includes development of film deposition and application, growth and application of van der Waals materials and their heterostructures, fabrication and characterization of nanostructures for field emission, thermal and high frequency RF applications. To date, Prof Tay has published more than 420 journal papers with Google Scholar H index of 75. Prof Tay is also a co-inventor of 17 international patents.

In 1999, Nanofilm Technologies Pte Ltd, a spin-off company, was established, licensing exclusively the IP developed at NTU on Filtered Cathodic Vacuum Arc technologies. The research team was subsequently awarded the ASEAN Outstanding Engineering Award and National Technology Award in 1997 and 2000 respectively for outstanding R&D contributions on a new Filtered Cathodic Vacuum Arc Technology, 2007 IES Prestigious Engineering Achievement Awards for their work in Nano-engineered Carbon Hybrid Systems. In 2020, the company raised its initial public offering (IPO).

Prof Tay's research has been recognized internationally where he works closely with companies, such as Nanofilm Technologies, IIA Technologies, Thales Group and Excelitas Technologies, where he also supervised several EDB Industry Postgraduate Programme (IPP) students. He is currently the Deputy Director of CINTRA, a UMI research unit cofounded by French National Centre for Scientific

Research (CNRS), NTU and Thales. He has been an invited speaker at numerous international conferences and universities.

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