International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

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ARCI

Cathodic Arc Physical Vapor Deposition Facility (CAPVD)

Overview

In general, Cathodic Arc PVD is a three step process: (i) Vaporization of required material from a source (cathode) by using an electric arc, (ii) Transport of vaporized material to the destination (target to be coated) and (iii) Condensation of transported vapours on to the targeted object to make a thin film. The major advantages of the CAPVD include; formation of highly dense and adherent coatings with a good deposition rate and thickness control (± 5 nm). The semi industrial available facility at ARCI is associated with 400 mm length (Φ: 110 mm) cylindrical cathodes which enable reduced droplets formation than any other conventional CAPVD facilities. The maximum dimensions of the target to be coated can be: 350 mm L x 100 mm W (Φ). The CAPVD facility with its unique advantages can be used for developing thin films/ coatings in major sectors like; auto mobile, aerospace, manufacturing, optics, electronics, alternate energy, etc.

Key Features

- Films/coatings of different structures with good control over chemistry and thickness can be developed: (i). Mono-layer, (ii) Multi-layer, (iii) Gradient and (iv) Functionally multi-layered/graded
- Films/coatings containing Ti, Cr, AlSi & AlTi can be coated in pure metallic or nitride or carbide form. i.e. TiN, CrN, TiAlN, TiAlSiN, CrAlSiN, TiCrAlSiN, TiC, TiCN, TiAlCN, etc.
- Physical and mechanical properties can be tuned by varying deposition conditions
- Environmentally green and easily up scalable process with high production rates

Fig: Hard coatings for cutting

Potential Applications

- Hard and wear resistant coatings for cutting tools – *up to hardness of 45 GPa*
  - High speed and dry machining
  - Machining of advanced materials: CGI, Ti6Al4V, Inconel 718, etc.
- Wear resistant coatings for dies, bearings, etc. – *Low friction coefficient of < 0.2*
- Erosion resistant coatings for compressor blades – *A thickness of 20 μm is achieved*
- Solar selective coatings for solar thermal applications – *~ α: 0.96 & ε: 0.09 at 400°C*
- Diffusion barrier coatings for electronic components
- Decorative coatings for aesthetic applications, etc.

Fig: Erosion resistance coatings for compressor blades tools

Intellectual Property Development Indices (IPDI)

- Different nanocomposite hard coatings were developed and tested for their performance
- 20 μm thick TiCrN erosion resistant coating developed
- TiCrCN wear resistant coatings were demonstrated for die applications
- Cr/TiCrAlN/TiAlN/AlSiN/AlSiO solar selective coatings were demonstrated on 75 mm diameter SS tubes (~ α: 0.96 & ε: 0.09 at 400°C)

Fig: Solar selective coatings for solar thermal receiver tubes tools

Major Patents / Publications

1. "An improved solar selective multi-layer coating and a method of depositing the same" Application No. 1567/DEL/2012, May 22nd 2012.
2. **"**Studies on cathodic arc PVD grown TiCrN based erosion resistant thin films" Krishna Valleti, Puneet C, Rama Krishna L, and Shrikant V. Joshi, JVST A 34, (2016): 041512
3. "High temperature stable solar selective coatings by cathodic arc PVD for heat collecting elements" Krishna Valleti, D. Murali Krishna, P. Mohan Reddy, Shrikant V. Joshi, *Solar Energy Materials and Solar Cells* 145 (2016):447

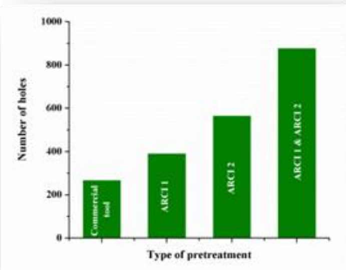

Fig: ARCI coatings machining performance relative to commercially available coated tools

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