

CTS Value Added Processes

Piezoelectric Capabilities

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CTS Corporation produces best in class high performance bulk and tape cast polycrystalline and single crystal piezoelectric materials. High volume and advanced value-added processing capabilities allow us to meet demanding customer specifications. CTS uses state of the art processes and equipment to develop innovative solutions for your piezoelectric needs.

MACHINING AND FORMING CAPABILITIES

CTS Corporation has 6 facilities located globally that cater to piezoelectric manufacturing with high volume precision machining and forming processes and equipment. Our capabilities cover the full range of customer applications and can produce piezo components as small as 1 mm up to 200 mm.

- High volume precision dicing
- Thin wafer grinding and lapping
- High volume wire slicing
- Fully automated CNC machining to produce complex ceramic geometries
- Uniaxial and isostatic pressing

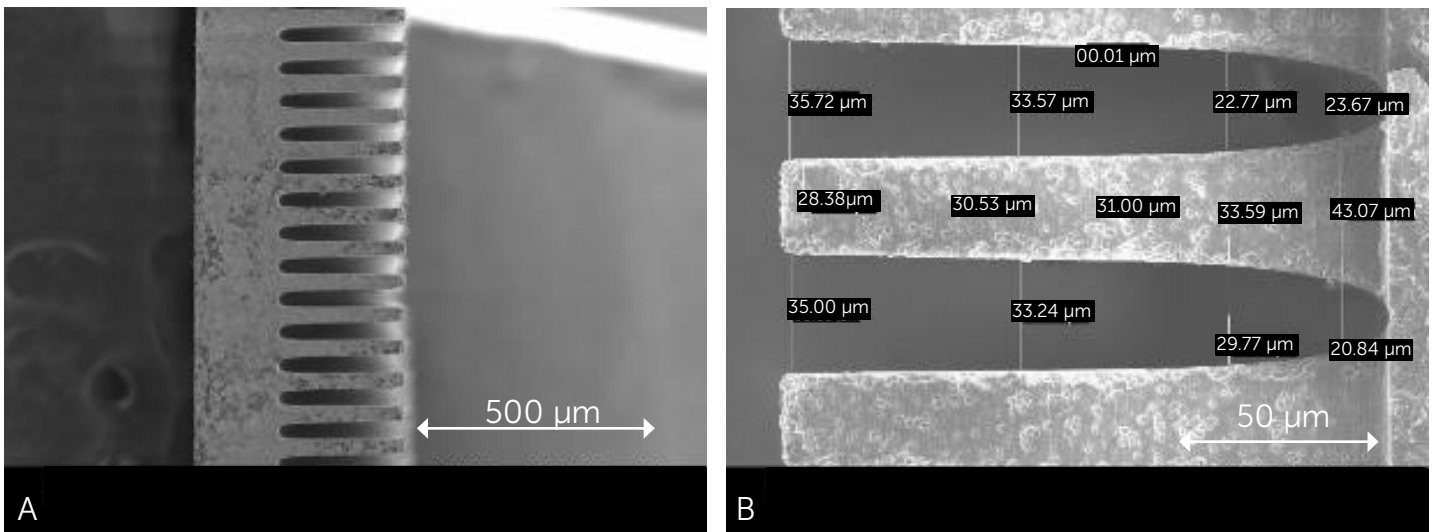


Figure 1: (a) Scanning Electron Microscopy (SEM) micrograph of diced PZT components showing accurate, repetitive and clean dicing cuts. (b) SEM micrograph showing detailed dice cuts with kerf widths as small as 25 μm

ELECTRODING CAPABILITIES

CTS has a wide range of Thin Film (Sputtering) and Thick Film (Silver Electrode) electrode deposition processes. With more than 15 sputtering systems globally, CTS can produce the following electrodes:

- Thin film sputtered electrode materials include NiCr, NiV, Ti, Au, and Ni
- Common sputtered film thicknesses range from 1,000 Å to 12,500 Å
- Thick film silver electrode thickness ranges from 10 μm to 15 μm
- Photolithographic patterning available on certain thin film electrodes

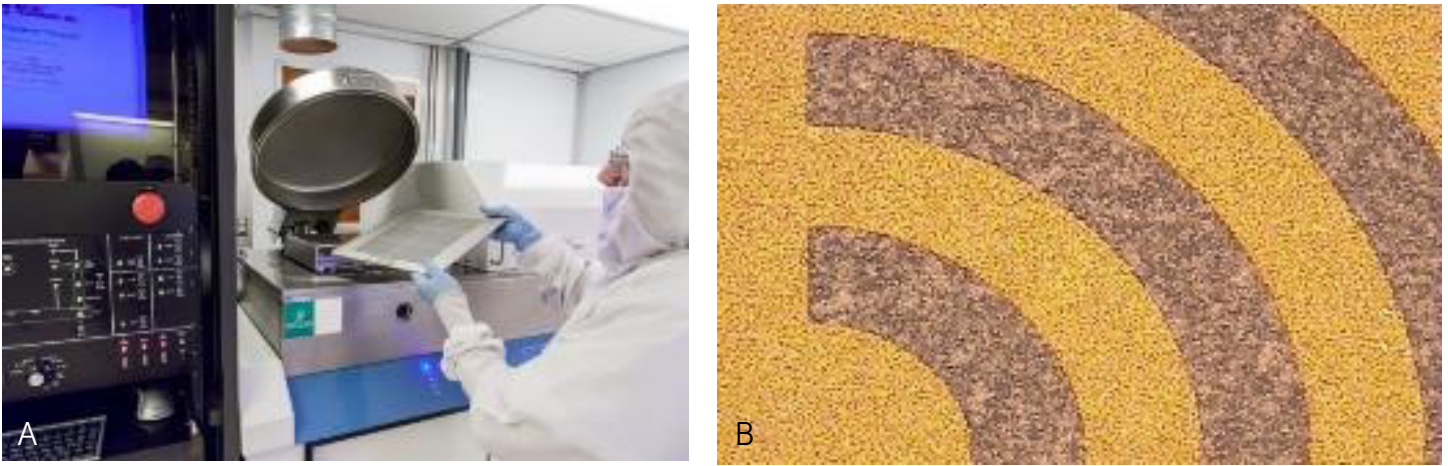


Figure. 2 (a) Operator loading wafers into high volume sputtering machine in CTS manufacturing facility (b) SEM micrograph showing etched pattern on sputtered Au electrode

COMPOSITE MANUFACTURING

CTS has extensive experience in the manufacture of 1-3 and 2-2 composites. A composite structure is achieved by interspersing channels or pillars of piezo with a polymer to improve impedance matching in medical, industrial and defense applications. Composites can be manufactured in numerous configurations according to the customer needs.

- Multiple polymer epoxy options in addition to ability to use customer specified epoxies
- PZT and single crystal composites can be produced as thin as 50 μm with 25 μm pillar sizes and 15 μm kerf
- Single Crystal composites can also utilize Reactive Ion Etching (RIE) processes to produce complex geometries such as rounded pillars.

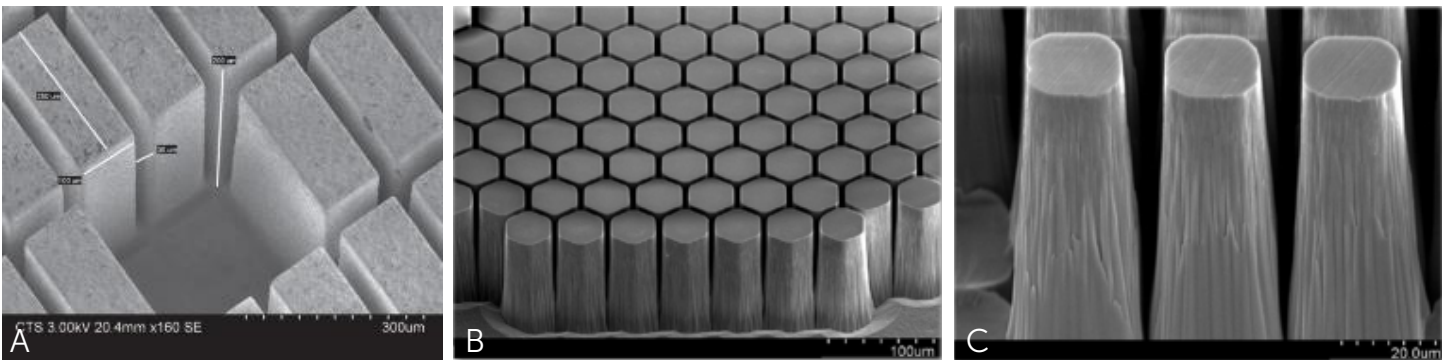


Figure. 3: (a) Diced 1-3 PZT component, (b) RIE processed PMN-PT showing hexagonal pillar shape, (c) RIE Processed PMN-PT with rectangular pillars.

VALUE ADDED, ADVANCED PROCESSING CAPABILITIES

- Tape and Frame Packaging
- Tape and Reel (R&R) Packaging
- Shadow Mask Sputtered Features
- Assembly, Lead Attachment
- Wafer Bonding Using State of the Art Epoxy Systems
- Pressure Testing (hydrophones, transducers)
- Soldering by J-Standard certified technicians

Facility	Location	Finishing Capabilities
A. Albuquerque, NM	United States	Dicing, Lapping, Grinding, Sputtering, Silver Electrode Application, Micro-Sandblasting, Composite Manufacturing, Tape and Frame Packaging
B. Lisle, IL	United States	Dicing, Lapping, Grinding, Sputtering, Silver Electrode Application, Micro-Sandblasting, Composite Manufacturing, Reactive Ion Etching, Tape and Frame Packaging
C. Nogales	Mexico	Dicing, Lapping, Grinding, Sputtering, Silver Electrode Application, Micro-Sandblasting
D. Tianjin	China	Dicing, Lapping, Grinding, Sputtering, Silver Electrode Application, Micro-Sandblasting, Composite Manufacturing, Tape and Frame Packaging, Tape and Reel (T&R) Packaging
E. Kvistgård	Denmark, Europe	Dicing, Sputtering, Platinum Electrode Tape Casting
F. Nupaky	Czech Republic, Europe	Grinding, Silver Electrode Application

ABOUT CTS

CTS Corporation is a leading developer and manufacturer of high-performance piezoelectric materials for a wide range of applications, including medical, defense, inkjet, industrial, oil and gas and automotive markets. Available in a variety of material compositions, these piezoelectric materials can be produced in various geometries in a comprehensive range of dimensions and in high volumes to support end-product specifications.

CTS offers a market leading level of possibilities for product customization of bulk products according to specific customer requirements.

With foundries in Europe and North America and additional finishing facilities in Asia and Mexico, CTS' global footprint is uniquely positioned to produce large volume programs and provide quality and reliable products to customers worldwide.



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