

Ultrasonic Additive Manufacturing (UAM) is an advanced hybrid manufacturing technology, which enables the embedding of electronic components and interconnections within solid metal structures, due to the low temperature/high plastic flow encountered during ultrasonic bonding. The UAM process is based on the ultrasonic metal welding of thin metal foils in a layer-by-layer fashion.

This work summarises the recent advances towards integration of UAM with printed electronics and other advanced manufacturing technologies for the encapsulation of conductive tracks and pre-packaged electronic components between the interfaces of the welded foils.

### 1<sup>st</sup> approach:

Screen printing was used to dispense a layer of isotropic conductive adhesive, between two layers of screen printed insulating polymer material, on a UAM fabricated substrate. Then the structure was encapsulated by resuming the welding process.

#### Advantages:

- No need for extra machining step - flexibility.
- The printing process can be controlled accurately.

#### Disadvantages:

- Short circuits may occur due to roughness of the substrate.
- There is a maximum limit in the thickness of the dielectric.
- Manufacturing in 3D is challenging.

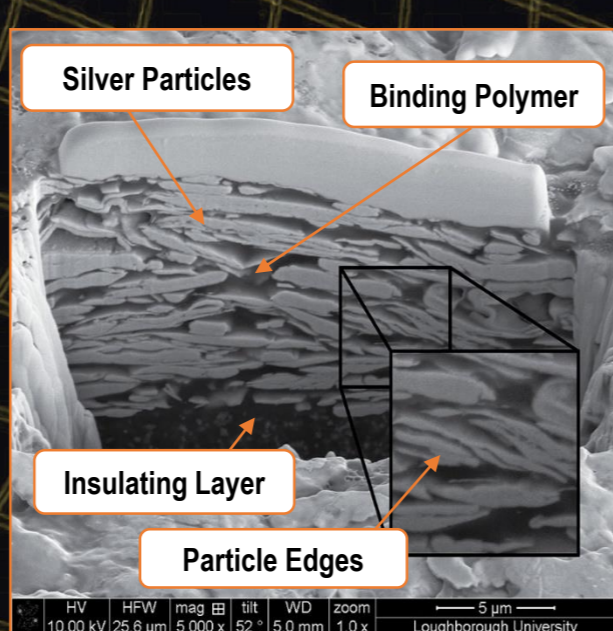
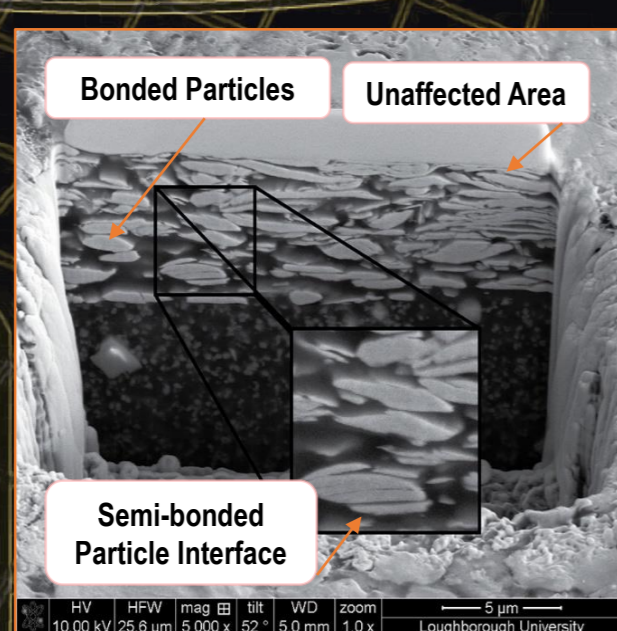
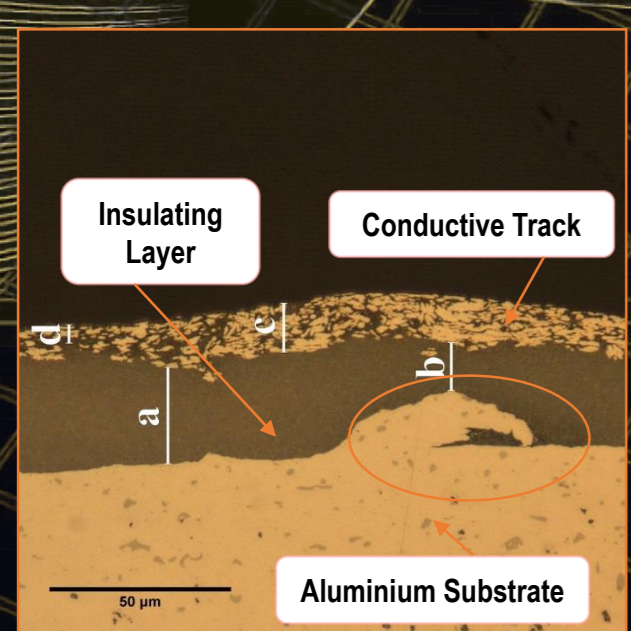
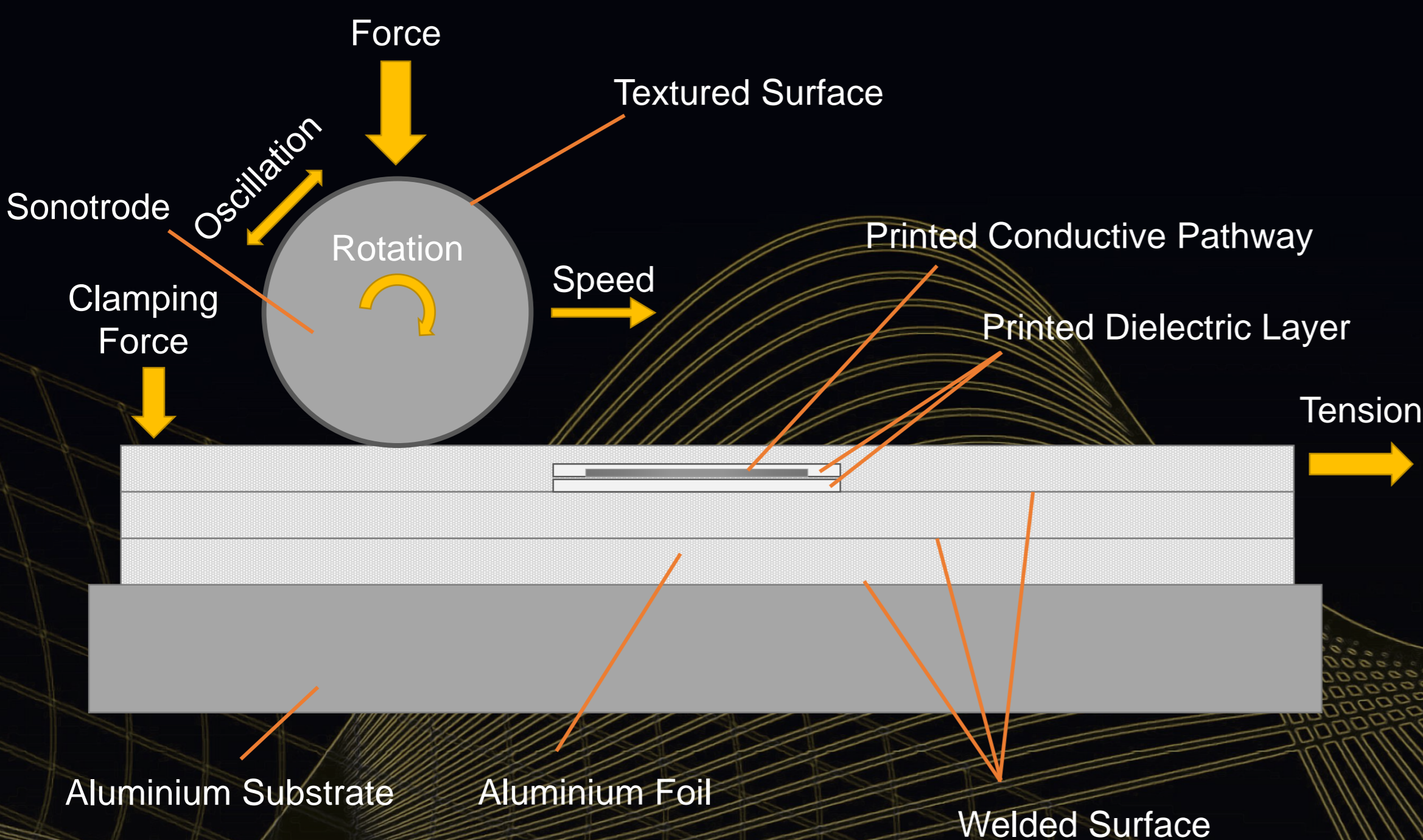


Fig. 1 : Cross section and optical imaging of screen printed sample

Fig. 2 : FIB/SEM imaging of UAM treated screen printed sample

Fig. 3 : FIB/SEM imaging of control screen printed sample

### 2<sup>nd</sup> approach:

The aluminium foils were selectively anodised prior to welding. Holes were drilled in the desired locations to work as through-hole vias. A direct write system was used for depositing the conductive tracks and filling of the vias. Electrical components can be placed in cavities.

#### Advantages:

- The process is unaffected by substrate's roughness.
- Good electrical insulation and thermal management can be achieved.
- Through-hole vias can be manufactured.

#### Disadvantages:

- An extra chemical treatment and machining pre-processing step is added.
- Intense process parameters can cause cracks in the alumina.

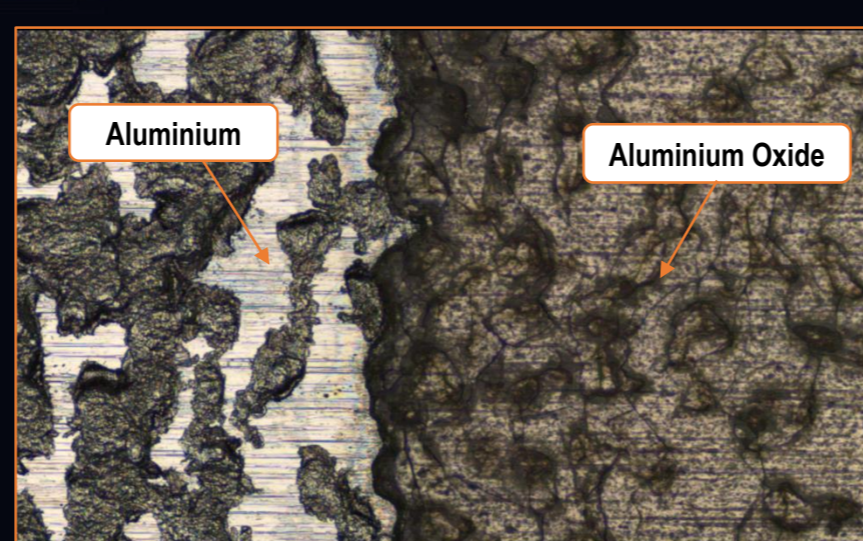
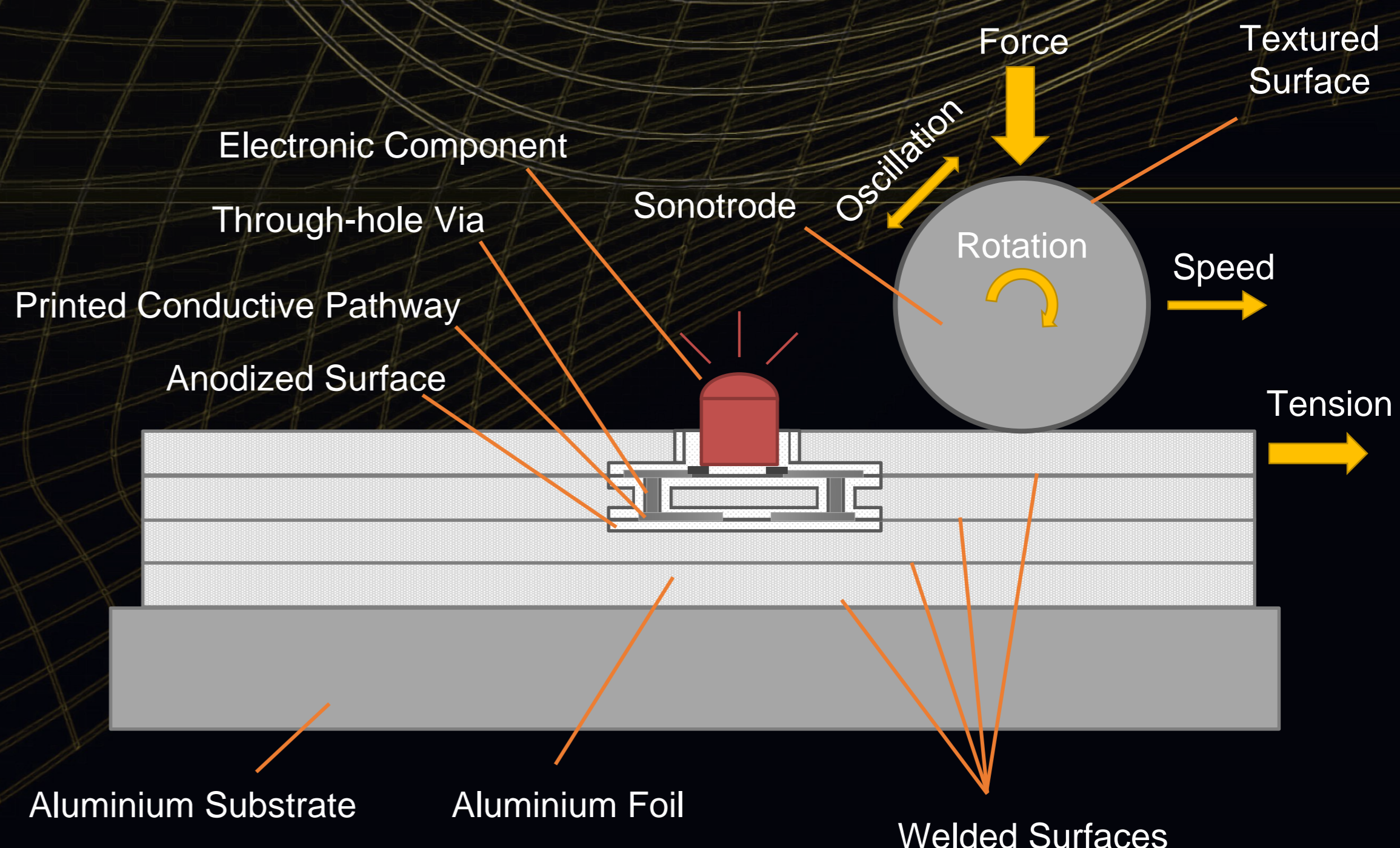


Fig. 3 : Top view of a welded pre-anodized foil

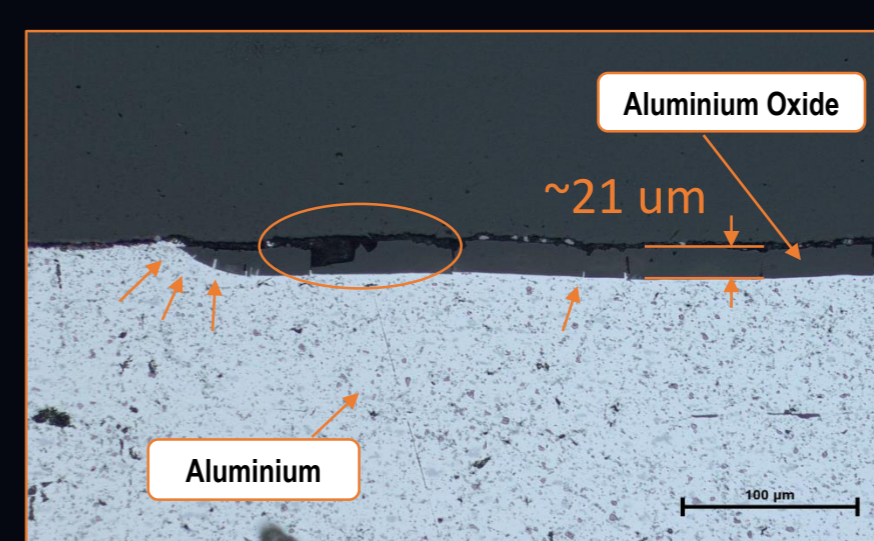


Fig. 4 : Cross section of a welded pre-anodized foil

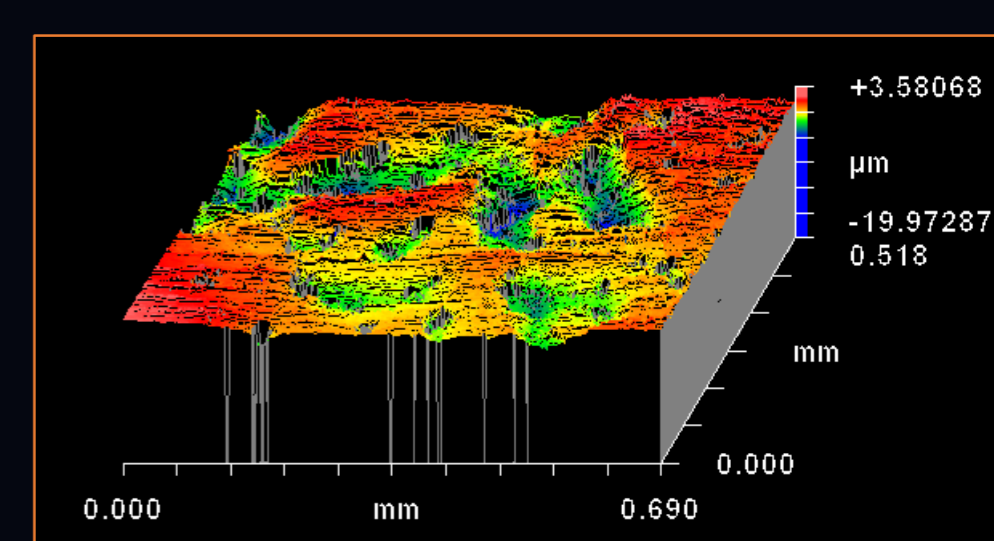


Fig. 5 : Surface roughness map of the alumina of a welded pre-anodized foil

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