UMONS Université de Mons

POLYTECH MONS

bcrc

UNION EUROPÉENNE

RÉGION WALLONNE

LE FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL ET LA RÉGION WALLONE INVESTISSENT DANS VOTRE AVENIR

http://europe.wallonie.be

SELECTIVE LASER HEAT TREATMENTS FOR REALIZING COATINGS AND THIN ELECTRIC COMPONENTS

PART 2: SINTERING OF $BaTiO_3$ BY SLS (SELECTIVE LASER SINTERING)

***N. Basile*[1], *M. Gonon*[1], *F. Petit*[2], *F. Cambier*[2]**

[1] Université de Mons, Faculté Polytechnique, Service de Science des Matériaux, 56, rue de l'Epargne, B-7000 Mons (Belgium)

[2] Belgium Ceramic Research Centre, 5, avenue du gouverneur Cornez, B-7000 Mons (Belgium)

Purpose

The behavior of barium titanate powders under selective laser sintering / melting is investigated. In a first stage, powder compacts have been treated in order to characterize the response of the powder according to the laser scan conditions (power, spot speed and vectorization step of the scan lines). Then specimens simulating a capacitor geometry (alumina substrate / Pt electrode / $BaTiO_3$ thick coating) where prepared.

Laser treatment of $BaTiO_3$ powder compacts

Figures below show optical microscope images of the surfaces obtained with different scanning conditions.

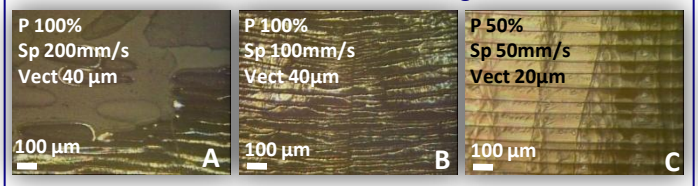


Figure A: With a high speed and large vectorization step, some areas of the scanned surface has not been transformed under the laser beam. A reaction seems to initiate only after several scan lines of the beam as if a "pre-heating" of the specimen is required.

Figure B: A lowering of the speed increases the heating efficiency.

Figure C: A lowering of power can be compensated by a slow speed and a narrow vectorization step. For this specimen, the structure of the scanned surface seems to be more homogeneous with large and well overlapped parallel scan lines.

Preparation of $BaTiO_3$ suspension

Water	90% vol.
Powder $BaTiO_3$	10% vol.
PAA (dispersant)	0.7% w. / $BaTiO_3$ powder
pH	10.5

Composition of the $BaTiO_3$ suspension

In order to homogenize the suspension and break the agglomerates it was soaked in a ball-mill. The distribution part greater than 1 µm was eliminated.

Laser treatment of $BaTiO_3$ powder coatings on alumina substrate

Figures below show SEM pictures of a $BaTiO_3$ coating after laser treatment at a speed of 200mm/s, a vectorization of 20 µm and a laser power of 100% on a surface of 1 x 1 cm².

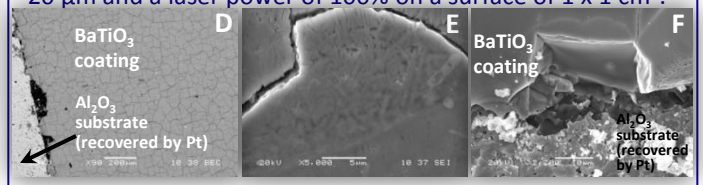
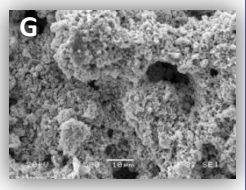


Figure D: Numerous cracks with a periodic distribution are observed. This can be due to the thermal gradient at the rear of the beam scan and the also to the difference in expansion coefficient between the $BaTiO_3$ layer and the substrate.

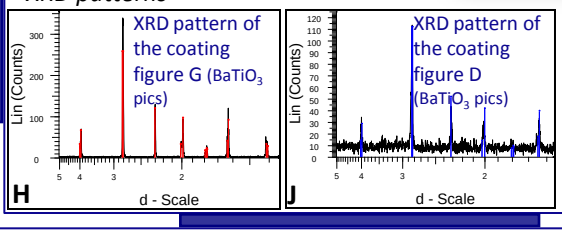
Figure E: Dendrite like structure is observed. This let to assume that the coating results of the melting and crystallization of the $BaTiO_3$ powder (EDX analysis: 20 at% Ba, 20 at% Ti and 60 at% O).

Figure F: At the edge of the scanned area it can be seen that the coating is fairly dense (thickness of about 18 µm).

Figure G: Coating of $BaTiO_3$ fired in conventionnal furnace at 1150°C.



XRD patterns



Degree of crystallization is minder on the sample treated by laser.

Conclusion

Laser parameters had been found to produce sintering /melting of a compact of $BaTiO_3$ powder. In order to create a microelectronic component, we have prepared an aqueous colloidal ink of $BaTiO_3$ with dispersant that can be deposited by spraying on alumina substrate recovered by platinum. Thanks to a study of the laser parameter (laser power, speed of the focus and vectorization) we have realized dense coating with a dendrite structure.