STRESZCZENIA WYSTĄPIEŃ PRACOWNIKÓW ITME NA KONFERENCJACH W 1997 R.

11th EUROPEAN FREQUENCY AND TIME FORUM
Neuchâtel, Switzerland, 4-6/03.1997

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MEASUREMENTS OF ELASTIC AND PIEZOELECTRIC CONSTANTS OF $Li_2B_4O_7$ CRYSTAL

Lithium tetraborate ($Li_2B_4O_7$) belongs to the 4 mm class of the tetragonal crystallographic system. It has six elastic, two piezoelectric and two dielectric constants. It was found, that there are large differences between some of the elastic and piezoelectric constants measured by different authors [1 - 3]. The crystal is a very interesting substrate material for small size surface acoustic wave (SAW) resonators and filters, and its parameters should be known with high accuracy. Therefore it was decided to remeasure the above constants using crystals grown at the Institute of Electronic Materials Technology. Three types of cuboids and one type of plate were prepared for these measurements. The bulk acoustic wave (BAW) velocities in the cuboids were measured using the pulse echo overlap (PEO) method. One of the electromechanical coupling coefficients was determined from the measured resonance and antiresonance frequencies of the plate. All elastic and piezoelectric constants were determined from the above measurements. One elastic and one piezoelectric constants were additionally obtained from measurements of Bleustein-Gulyaev wave (BGW) parameters [4]. The obtained results will be compared with other published values.

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Tekst wydrukowany będzie w materiałach z konferencji.

11th EUROPEAN FREQUENCY AND TIME FORUM
Neuchâtel, Switzerland, 4-6/03.1997

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COMPENSATION OF WAVEGUIDING EFFECTS IN SURFACE ACOUSTIC WAVE FILTERS

Modern applications of SAW filters require precise compensation of various second-order effects which degrade the performance of these devices. On the other hand interdigital transducers of narrow acoustic aperture (less than 20 λ) are widely used in SAW filters to reduce their cost. SAW diffraction severely degrades the frequency responses of such filters. Unfortunately, it is difficult to develop a mathematical model properly describing the diffraction problem within a narrow IDT. Most published papers on diffraction compensation assumed a 'free diffraction' model neglecting the guiding of SAW energy by the IDT fingers and bus bars. Waveguiding effects especially degrade the frequency responses of narrow aperture filters using strong piezoelectric materials like lithium niobate as a substrate. The methods of waveguiding effects compensation have been published previously. However, application of these methods is limited to narrow band compensation of waveguiding effects in filters which preferably guide a single mode.

This paper proposes a wide band compensation method which can be used for filters supporting any number of propagating modes. According to the method constrained optimization techniques are used to appropriately modify the apodization pattern. Quasistatic theory is applied to model SAW generation and detection in the IDTs. SAW diffraction and waveguiding effects are modelled using the method of filter analysis described by Clark and Milsom. The developed mathematical model of the device requires much less computer time than the 'free diffraction' model using so called parabolic approximation. The described compensation method was used to design many TV-IF SAW filters on 128° YX $LiNbO_3$. The paper presents both theoretical and experimental compensation results for some of these filters. Waveguiding effects in one of the filters were suppressed by the application of the damping

compound (epoxy resin) to the substrate surface between the active IDT area and the adjacent long substrate edges. The results of this suppresion were compared with the results obtained by the application of the proposed compensation method.

Materiał prezentowano na sesji referatów.
Pełny tekst będzie wydrukowany w materiałach konferencyjnych.

EUROPEAN CONFERENCE ON WELDING AND JOINING SCIENCE AND TECHNOLOGY, Madrid, Spaine, 10-12/03. 1997

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NATURE AND MORPHOLOGY OF THE JOINTS OF METAL MATRIX COMPOSITES TO METALS

Metal matrix composites (MMCs) reinforced with short ceramic fibres (*e.g.* carbon or Al_2O_3 fibres) or with other metals (such as *e.g.*, tungsten) show numerous advantages since their properties can be programmed by modifying appropriately their composition and technology. A point of considerable importance is the possibility of joining the composites with metals or their alloys. The major problem here is to choose the appropriate joining technique, such that ensures the formation of a high quality joint resistant to the service conditions, avoids the degradation of the composite microstructure, in particular of the interface layer between the matrix and the reinforcement, and, still, is not expensive.

The paper presents the results of experiments on joining the following composites: 6061Al- based materials containing 15 vol.% of δ - alumina fibres, CuCr1 - based materials containing 20 vol.% of carbon fibres (C_f), CuZr1-based materials containing 20 vol.% of C_f and Cu - based materials with 10 vol.% of dispersed tungsten powder. The CuCr1-C_f and CuZr1-C_f composites were joined with austenitic steel, the 6061Al-Al_2O_3 composite - with the 6061Al alloy and the CuW composite - with copper of 99.99 % purity. The material pairs were chosen so as to take into account their possible application. Several different joining techniques were examined.

This paper discusses the results obtained when using diffusion bonding, vacuum brazing and gluing.

The morphology and the nature of the interface layer after bonding process between the matrix and the reinforcement and between the MMCs and metal were examined by analysing the distributions of the elements, by SEM and by X-ray techniques. The degree of the degradation of the MMCs structure was taken to be

described by the coefficient of the relative content of the reinforcing material RCRM = X/B, where X is the percent content of the reinforcing phase in the composite after the joining process, and B is the percent content of this phase in the starting material.

The paper discusses how the nature and morphology of the MMCs to metals joins varies with the joining techniques.

Experimental procedure
MATERIALS

The materials used for the experiments were.

• 6061Al - based materials containing 15 vol.% of δ - alumina fibres.

The 6061Al alloy was of the following composition (by weight): 1% Mg, 0.6 % Si, 0.25 % Cu, 0.25 % Cr, Al - balance. The δ - Al_2O_3 fibres were 1.5 - 6 μm in diam. and 25 μm in length. The composites were manufactured by direct hot extrusion.

Materiał prezentowano na sesji referatów.
Pełny tekst będzie drukowany w materiałach z konferencji.

EUROMAT'97 5th EUROPEAN CONFERENCE ON ADVANCED MATERIALS, PROCESSES AND APPLICATIONS
Maastricht, The Netherlands, 21-23/04.1997

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BRAZING OF ALUMINA TO STEEL USING ULTRASONIC INTENSIFICATION

This paper contains an analysis of properties of the alumina - corrosion resistance steel that were joining by using brazing active silver filler metals made in Degussa Co. (commercial names: CB 1 and CB 4). The experiments of vacuum brazing were run at temperature 1013 K ÷ 1223 K using additionally longitudinal ultrasonic vibrations. There were made structural of the interface and strength investigations. There were shown, that bending strength of the joints with ultrasonic activation is 40 % higher than strength of joints bonding without ultrasonic. There were observed that growing of the joining temperature take joint strength lower. The joints bonding without ultrasonic had some concentration of Fe and Al elements in the joint interface zone. The process ultrasonic intensification permits decrease of the joining temperature.

Materiał prezentowano na sesji posterów.
Tekst został wydrukowany w materiałach z konferencji, Tom I.

EUROMAT'97 5th EUROPEAN CONFERENCE ON ADVANCED MATERIALS, PROCESSES AND APPLICATIONS Maastricht, The Netherlands, 21-23/04.1997

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RELATION BETWEEN THE MECHANICAL STRENGTH OF THE CERAMIC-METAL JOINTS PRODUCED BY ACTIVE BRAZING AND THE MICROSTRUCTURE OF THE TRANSITION LAYER

The properties of ceramics-metal joints bonded by active brazing in a vacuum of 1.33×10^{-3} Pa or in a nitrogen atmosphere with about 10 ppm of oxygen were examined. The brazes used were the commercial brazes CB 1 (AgCul9.5In5Ti3), CB 4 (AgCuTi2.4) and the AgCu28 braze with TiH_2. Alumina ceramics was join with the FeNi42 alloy and with oxygen-free copper. The mechanical strength and vacuum tightness of the joints thus obtained were examined.

It has been found that both the mechanical strength and the vacuum tightness of the joints depend on the brazing temperature and on the kind of the materials being joined. As the temperature increases, the number of vacuum tight joints decreases whereas their tensile strength increases. More vacuum tight joints were obtained when joining ceramics with copper than when ceramics were joined with the FeNi42 alloy.

The transition layers formed on the ceramics during brazing in various atmospheres were examined using X-ray techniques and electron microscopy. The phase composition of the transition layer was found to depend on the brazing conditions (vacuum or a nitrogen atmosphere). When using a nitrogen atmosphere, the oxide compounds TiO_2 and Fe_2O_3 were identified, absent when the brazing was carried out under vacuum; moreover, the synthesis of dioxide compounds of the Cu-O-Ti system appeared to be limited. The increased mechanical strength of the joints brazed in the presence of a certain defined amount of oxygen may suggest that the synthesis of oxide compounds proceeds through bonding the oxygen from the nitrogen atmosphere, thanks to which the surface destruction of alumina is restricted.

The results of microstructural examinations of the ceramics-FeNi42 alloy joints

suggest that the poor vacuum tightness of these joints may be due to the considerable changes of the microstructure of both the FeNi42 alloy and Al_2O_3 that take place during brazing.

The transition layer formed at the surface of the ceramic as a result of the diffusion processes does not deform under load and thus makes the joint liable to accidental catastrophic damage.

It has also been found that the way in which the joints deform (brittle or semiplastic) under load depends on the kind of the transition layer formed on the ceramic.

Materiał prezentowano na sesji posterów.
Tekst został wydrukowany będzie w materiałach z konferencji, Tom II.

IMAP/NATO ADVANCED RESEARCH WORKSHOP
Bled, Slovenia, 10-13/05.1997

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PHOTOSENSITIVE POLYMER THICK FILMS

Polymer thick films (PTF) have got over thirty years history. Contained in the pastes organic polymers, unlike in case of the ordinary cermet pastes, remain in the layer for the entire life of an electronic device play a very important role. They decisively affect technological processes (application of the paste, curing conditions, kind of substrates, trimming, etc.), as well as final parameters of the layers (line resolution, glass transition temperature - Tg, coefficient of thermal expansion - (TCE), water absorption, dielectric constant, dissipation factor, stability, etc.).

A short review of advantages and disadvantages of employing different polymers to PTF's is presented.

Out of commonly used in PTF's thermoplastic, thermosetting and UV cured polymers (polyacrylates, epoxy resins, polyurethane, phenolic resins, polysilicanes, polyimides, epoxyacrylates, etc.) the UV curable version of the latter group of polymers was selected for the investigation. The synthesis of broad range of the UV curable epoxyacrylates was performed in the authors laboratory.

The experiments carried were focused on the conductive and dielectric pastes. Results of the investigation of these pastes are presented. Possible application of such paste is discussed.

Materiał prezentowano na sesji referatów.
Pełny tekst wydrukowany będzie w: Electronic Packaging for High Relability.