Conference of bonding in optics and photonics

december 8th, 2005 - in Sophia Antipolis - France

PROGRAMME

8 : 30 Reception

9 : 15 POPsud, Serge UNGAR
9 : 30 CARMA, Jean-Claude GIANNOTTA
Bonding in optics and photonics : specifications
10 : 00 CNES, Vincent COSTES
Bonding in optics and photonics and optical instrumentation for spatial application

'Adhesives' session

10 : 30 KLOÉ, Cécile AUBERT and Paul COUDRAY
K-Px, bonding hybrid materials

11 : 00 Posters session

11 : 30 DYMAX, René RUÉ
Light curing technology
12 : 00 NUSIL TECHNOLOGY EUROPE, Olivier CHANDY
The place of silicone in optical industry
12 : 30 Lunch

'Physical characterisations' session

14 : 00 INSIDIX, Jean-Claude LECOMTE
Topography and deformation Measurement complemented with Acoustic Microscopy
14 : 30 RESCOLL, Pierre DALET
Applications of thermomechanical and interfacial characterisations for optical bonding

'Bonding solutions in optics and photonics' session

15 : 00 ALCATEL ALENIA SPACE FRANCE, Jean-Noël DEFOIS and Roger VIALE
Applications of bonding solutions in space opto-mechanical domain

15 : 30 Posters session

16 : 00 SESO, Jean-Jacques FERMÉ
Optical contacting
16 : 30 PLASMA QUEST LIMITED, Anne BOYÉ
High density plasma deposition
17 : 00 SEOP, Gérard GREISS
The issue of using complex optics in extreme medium of cold

17 : 30 Conclusions

ORAL COMMUNICATION ABSTRACTS

POPsud - Serge UNGAR

POPsud, promotes photonics in the South of France.

Born in 2000, the "Pole Optique & Photonique Sud" (POPsud) aims at promoting and developing photonics in Provence. Since its birth, the association has set up a network of companies and laboratories which is now very developed. POPsud's membership has tripled in the last 5 years reaching now more than 120 members. Today, POPsud is nothing less than 69 companies, 25 laboratories and 31 partners.
This development has been growing together with a greater influence of the association outside the boundaries of Provence-Alpes-Côte d'Azur. Indeed, nearly 17 % of our membership is located out of the PACA region. This territorial expansion corresponds to our will to valorise optics and photonics over the whole South of France and to establish inter-regional connections, more specifically with Midi-Pyrénées, Languedoc-Roussillon and Rhône-Alpes.
Today, POPsud is recognized as a major actor of Photonics in France and has developed several common projects with other optical clusters in Canada, China, Italy, Greece, Israel and the United Kingdom.

CARMA - Jean-Claude GIANNOTTA "Bonding in optics and photonics : specifications"

The bonding in the field of optics and photonics is characterized by specific criteria of applications which can be summarized by the following properties of the adhesives :

- transparency ;
- resistant behaviour versus the temperature, especially in some optical applications (space, aeronautics) requiring a good behaviour since the low cryogenic temperatures at the high temperatures) ;
- adaptation to the vibrations.

Others applications require adhesives with strong electric conductivity and others with strong thermal conductivity. The supports of optics are varied since glasses like borosilicates, the zerodur, the AMTIR, the Invar and also plastics like the PC and the PMMA. These supports have sometimes very low thermal coefficient of expansion allow the joints adhesive bonded to generate very low constraints of differential expansions, even for variations in very high temperature.

ADHERIA®, the data base of the adhesives developed by the CARMA, gathers more than 1500 adhesives from 45 suppliers. Among these adhesives, ADHERIA® counts about fifteen suppliers presenting of the adhesives used in the optics and the photonics one among which Dymax, Epoxy Technology, Kloé, Loctite, Epotecny, Nusil, Protavic, Polytec pi, Supratec, Ge Silicones, Vishay, Henkel, Intertronics, Master Bond, 3M. Among these references, one will find a hundred UV curables adhesives, a hundred component mono epoxy adhesives and 200 epoxies bi-components, a hundred acrylic resins, a hundred cyanoacrylate, nearly 200 references of silicone and approximately 70 polyurethanes being characterized all by their physical, mechanical or rheological properties.
Among all these adhesives, several can answer a problem of bonding in optics if we look for all of the criteria of the specifications and if all the validation tests are carried out, first on the samples and then on the material.

CNES - Vincent COSTES "Bonding in optics and photonics and optical instrumentation for spatial application"

Optical cameras, photometers, lasers and spectrometers have been developed or are under development for CNES optical programs. An overview of optical devices is given. Key examples with quite different needs are shown. Their specific and stringent bonding constraints are described. The main requirements of SPOT, PLEIADES and COROT telescopes, of SPOT focal plane, of PLEIADES specific CCD, of the IASI corner cube, of the COROT bi-prism and of CHEMCAM laser cavity will be discussed. The specific constraints of our spatial applications are outlined. Preparing the future, CNES is leading research and technology activities involving bonding issues. Some cases with critical trade off and validation of the chosen bonding solution will be pointed out.

KLOÉ - Cécile AUBERT and Paul COUDRAY "K-Px, bonding hybrid materials"

Photopolymerizable or thermal, Kloé developed and patented a range of high performances hybrid adhesives for varied applications (optics, photonics, microelectronics, aerospace...).

Their compositions, which combine organic and mineral, allow to join materials of different kinds traditionally incompatibles, such as glass, metals, semiconductors or polymers. Their "composite" character confers them high mechanical and chemical stabilities as well as a very weak shrinkage with photopolymerization. In this way bondings obtained show a very good resistance to moisture, acids, bases, alcohols, ultrasounds and cutting under water jet. The optimization of organic/inorganic combinations allowed Kloé to develop high thermal resistance adhesives (~200°C) as well as a very broad range of viscosities (10-1000cP). Nowadays Kloé works on the development of adhesives with specific properties (very weak thermal dilation, high resistance to flux...).

DYMAX - René RUÉ "Light curing technology"

« I think, there is a world market for may be five computers » (T. Watson, Chairman of IBM, 1943)
“640KB ought to be enough for anybody” (Bill Gates, 1981)
Of course, semiconductor industry in the 1980’s was slow due to manual assembly, high raw material costs and expensive assembly applications. In terms of materials used Epoxy was mostly the material of choice.
However, to support the required output growth, the industry had to move away from manual assembly processes. This was felt across industries and as such in the opto, opto-electronic and photonic industry. Automated assembly processes supported cheaper production but set new standards with respect to material properties and their ability to comply with advanced assembly requirements.
Hence, efficiency, cycle time and cost considerations came into play. From early stages on DYMAX with its technology driven innovation activities accompanied manufactures in their search for higher yield and higher productivity.
It was in the 1980’s that DYMAX pioneered the advancement of resins in industrial assembly applications. Since then DYMAX specializes in high volume support for Lens, Prism and Doublet bonding, Optical Diode materials, Fibre Optic applications and Opto-Electronics.
In its R&D efforts DYMAX continues to take into account modern materials and their requirements and the high-performance needs of efforts towards miniaturization and integration.
With over 25 years of experience in UV adhesives the DYMAX Light Curing Technology can help design an assembly process that will meet your needs. By combining advanced UV/Visible light curing equipment and the most advanced adhesive chemistry, DYMAX is taking UV technology to a new level.

NUSIL TECHNOLOGY EUROPE - Olivier CHANDY "The place of silicone in optical industry"

The development of new technologies in the field of optic has created new technical requests that couldn't be supported by "traditional" materials like PMMA, Epoxy or acrylate but only by silicone.
Nusil Technology, a leader in the formulation of silicone raw materials has created a vast range of products dedicated to optical industries (photonics, space, …). To better analyse needs of our customer and support them, Nusil Technology has worked to develop a high technical level on their materials through characterization, formulation, analyze,..
Topics discussed during this presentation are :

- Applications where silicone is involved
- Bases to formulate a silicone for an optical application
- Major parameters requested for selecting a material (absorption Vs. wavelength,..)
- Bonding results obtained on substrats commonly used in optic
- UV Ageing of silicone Vs. other materials

Most of these information are available on our website through white papers www.nusil.com

INSIDIX - Jean-Claude LECOMTE "Topography and deformation Measurement complemented with Acoustic Microscopy"

Topography and Deformation Measurements (T.D.M.) under thermo-mechanical solicitation is a new approach for : package development ; materials property measurements : CTE / Polymerization / Phases changes ; simulation help ; assembly and repair process qualification ; evaluation of lead free consequences ; reliability evaluation ; in service stress evaluation : On / Off ; failure prediction.
The main points in this paper concern failure prediction using T.D.M. complemented with acoustic microscopy inspection for different electronic assemblies.
Cooling and heating capabilities, with different temperature rate and maximum, following Jedec thermal profiles for example, have been applied on different components before and after assembly using real time Topography and Deformation Measurements.
The interest in being able to perform z and (x, y) deformation measurements for traction / compression and shear stress evaluation will be shown. Using acoustic microscopy before and after thermal stress gives the possibility to detect the conditions in which elastics limits may have exceeded at interfaces, which interface is concerned and the speed at which delamination occurs.
Complementarities of this new technique with acoustic microscopy and simulation will be shown for failure prediction applications.

RESCOLL - Pierre DALET "Applications of thermomechanical and interfacial characterisations for optical bonding"

The polymer industry has grown at an astonishing rate, for instance increasing from 30 million tons/year produced in 1970 to 169 million tons/year by 2003 for thermoplastics. Furthermore an ever-expanding use of macromolecular-based formulations can be observed in many industrial applications, especially for technological bonding. Consequently new methods that have significantly improved the material characterisation have been developed, and thermomechanical analyses are not exceptions.

Monitoring a sample property against time or temperature, these methods provide a deep insight concerning thermal and mechanical properties, processes and transformations. They are indeed a great tool to improve performances, to prevent from unexpected ageing or to reduce production costs, as it can be seen through some industrial studies conducted by RESCOLL.

ALCATEL ALENIA SPACE - Jean-Noël DEFOIS and Roger VIALE "Applications of bonding solutions in space opto-mechanical domain"

In opto-mechanical domain, bonding is already very often preferred to other solutions of connections. Its applications in this domain have really a promising future on account of the numerous advantages of the bonding (large field of products, great adaptability, relative easiness of the realisation, reduced fixation sizes, high strength performances, very limited mass,…) and, last but not least, two majors advantages,

. soft interface created between metallic parts and brittle optical ones,

. rather easy management of induced stresses and deflections

Bonded connections for spatial projects are subjected to stringent conditions :

. temperature excursions from roughly +60 °C down to –170 °C for the structural fixations and down to –290 ° C for bonding of thermal control components,…..for the time being!

. at least some tens of thermal cycles on ground, then several years of storage in ambient humidity and finally launch and several years in cryogenic conditions,

. several tens of vibrations runs at maximal load level, i.e. some tens of g.

Materials used for the various spatial optics include from metallic ones (not often) to the complete field of ceramics, without forgetting composite materials (CFRP and carbon/carbon); the most usual materials are ceramic ones (SiC, CeSiC, and all the kinds of glasses). It results specific processes to implement each of these materials and almost each connection assembly : adhesive choice, adaptation of surface treatments, process to bond and to check the integrity of the bonding.

The strength of bonded connections is a phenomenon rather complex involving numerous parameters relative to adhesive, to adhesion surfaces and to assembled materials. It remains difficult to predict their performances with accuracy, leading often to rather long and iterative studies and tests.

With composite materials and above all with ceramics, weak component is no more bonding, but adherent material itself. Ceramics, brittle and sensitive to static fatigue phenomenon, make mandatory a very good knowledge of the behaviour and of the particular rules of design and of sizing of such materials.

Adhesive keeps nevertheless an essential role as deeply involved :

. in the very local mechanical and thermal-elastic over-stresses which lead first to the partial degradations (acceptable under control) then to complete failure,

. in the thermal-elastic deflections induced in the optic during the cool-down, with allowable deformations limited to some nano-or even pico-meters! A very good knowledge of the behaviour of the adhesive remains thus quite important in the whole temperature range, which leads to some characterization difficulties.

Often faced to needs for advanced bonded connections, ALCATEL ALENIA SPACE has developed since several years a methodology to characterise adhesives and adherents and efficient tools to predict with high accuracy (un certainty = 15 %) the strength of bondings, including those subjected to complex loading cases. That allows :

. an optimization from the beginning of the design : the optimized definition is achieved directly by analysis and not by successive tests

. and thus significant savings in cost, schedule, performances and reliability,

A survey of the application scope is given through the validation panel and in particular by four examples of bonded assemblies subjected to large temperature excursions, of which three in the cryogenic domain.

SESO - Jean-Jacques FERMÉ "Optical contacting"

Optical contacting is a very interesting technology to achieve stable assembly.

We will describe the last results that were achieved in this technology with different unusual materials as Silicon, Silicon Carbide and present some example of complex assembly :

- Double Fabry-Perot qualified for space application ;
- Stabilised bench for ultra stables wavelength lock-up system.

PLASMA QUEST LIMITED - Anne BOYÉ and Anthony ANDY "High density plasma deposition"

This paper reviews the results obtained using a thin film coating system that incorporates novel high-density plasma generation and sputter deposition technology to overcome several of the limitations inherent in other thin film deposition techniques. The benefits include high target utilization (>95 %), the ability to sputter thick ferromagnetic materials, high rate and stable reactive sputtering, deposition of low bonding stress films with optical properties approaching bulk, and maintenance of stoichiometry from compound targets.
The technology is based upon generating an intense plasma (>1013 cm-3) remotely from the sputter target and then magnetically 'steering' the plasma to the target to enable sputter deposition processes to be run. Recent development activity has revealed potential new applications and benefits, including demonstrated control for the bonding of stress free films onto flexible organic substrates, very low deposition rates for ultra thin films (e.g. alumina at <0.3 nm.min-1), excellent wave guiding properties (optical applications), and very high rate deposition of stress free alumina films.

SEOP - Gérard GREISS "The issue of using complex optics in extreme medium of cold"

Located close to the south pole, the Franco-Italian Concordia station has the particularity to offer high dynamic range conditions for astronomy, allowing to do quasi-spatial observations.
This project aims at testing a complete stellar coronagraph testbed, including a telescope, a coronagraph with no tip-tilt correction, 2 detectors and a system of image processing.

The issue of using complex optics is the refraction/ of materials because glasses have different indexes and densities and the watertightness of the systems.
Two process were tested : the adherence and the bonding with testing temperatures of -60 °C.

This project is realized in collaboration with the Laboratoire Universitaire d'Astrophysique de Nice (LUAN)