Final Year Project Proposal 1

Project Title:
Mechanical testing for high temperature polymers

Supervisor:
Assoc. Prof. Gan Chee Lip

Mentor:
Mr Eric Phua Jian Rong (JRPhua@ntu.edu.sg)

Description:
In offshore subsea drilling, different types of microelectronics devices and sensors are needed for logging while drilling (LWD). However, the high temperature, high pressure and even changes in electrochemistry in the operating environment, pose a challenge to the electronic packages' survivability. In this project, various modes of characterization are required to identify suitable high temperature polymeric gap fill materials in electronic packages. This project is focused mainly on testing.

Methodology:
High temperature polymeric materials will be used in this project for filling up electronic packages. Prior to that, selected polymers will be characterized to check their suitability for the environments which they would be placed in. Compatible polymers identified will be placed into actual packages, which will subsequently undergo mechanical reliability tests.

Equipment:
Bond shear testing, CSAM (IME)
Instron tester, Bend test (NTU)

Remarks:
Student will have the opportunity to carry out some work at the Institute of Microelectronics.
Majority of work will still be carried out in NTU.

Final Year Project Proposal 2

Project Title:
Characterization of high temperature polymers

Supervisor:
Assoc. Prof. Gan Chee Lip

Mentor:
Mr Eric Phua Jian Rong (JRPhua@ntu.edu.sg)

Description:
Ruggedized electronics is crucial to ensure continuous operation during oil drilling (e.g. Logging While Drilling) operations in subsea drilling environments. High temperature, pressure and other modes of mechanical stresses pose a challenge to the electronics survivability. In this project, various modes of characterization are required to identify suitable high temperature polymeric derivatives in electronic packages.

Methodology:
High temperature polymeric materials will be used in this project for filling up packages. Prior to that, selected polymers will be characterized to check their suitability for the environments which they would be placed in. The various tests to be carried out are listed below. Compatible polymers identified would be placed into actual packages which would subsequently undergo electrical and mechanical reliability tests.

Equipment:
DSC, TGA, DMA, SEM, TMA, FTIR

Remarks:
All work will be based in NTU.

Final Year Project Proposal 3

Project Title:
Characterization of high temperature polymers

Supervisor:
Assoc. Prof. Gan Chee Lip

Mentor:
Mr Eric Phua Jian Rong (JRPhua@ntu.edu.sg)

Description:
Ruggedized electronics is crucial to ensure continuous operation during oil drilling (e.g. Logging While Drilling) operations in subsea drilling environments. High temperature, pressure and other modes of mechanical stresses pose a challenge to the electronics survivability. In this project, various modes of characterization are required to identify suitable high temperature polymeric derivatives in electronic packages.

Methodology:
High temperature polymeric materials will be used in this project for filling up packages. Prior to that, selected polymers will be characterized to check their suitability for the environments which they would be placed in. The various tests to be carried out are listed below. Compatible polymers identified would be placed into actual packages which would subsequently undergo electrical and mechanical reliability tests.

Equipment:
DSC, TGA, DMA, SEM, TMA, FTIR

Remarks:
All work will be based in NTU. Similar to proposal 2 but student will work on a different polymeric system.

Final Year Project Proposal 4

Project Title:
Mechanical failure study of electronic packages under high pressure and high temperature environments

Supervisor:
Assoc. Prof. Gan Chee Lip

Mentor:
Mr Eric Phua Jian Rong (JRPhua@ntu.edu.sg)

Description:
Ruggedized electronics is crucial to ensure continuous operation during drilling operations in subsea drilling environments. High temperature, high pressure and other modes of mechanical stresses pose a challenge to their survivability in the operating environment. In this project, the student will study and compare traditional modes of packaging with newly developed high temperature high pressure suitable packages suitable for the oil and gas industry.

Methodology:
High temperature materials will be used in this case for electronic packaging. Packaging will be carried out, follow by electrical and mechanical studies in various test environments. Simulation studies may also be conducted and student will be guided to perform such studies.

Equipment:
Vibration systems, high temperature equipment, high pressure equipment, SEM, simulation

Remarks:
Work will be carried out in NTU. Interest in simulation.

Final Year Project Proposal 5

Project Title:
Compositional dependence of Sn-Bi solder on the intermetallic compound (IMC) growth kinetics with Cu at thin film scales

Supervisor:
Assoc. Prof. Gan Chee Lip

Mentor:
Dr Wardhana Sasangka (wardhana@smart.mit.edu)

Description:
Incorporating different elements into Sn solder has become an efficient way to control the growth rate of IMC that form with Cu film. However, which composition allows the fastest/slowest IMC growth is not yet fully understood. The existing methodology using ex-situ heating followed by cross-sectional analysis does not only suffer in accuracy but also requires rigorous effort in implementation and therefore inefficient to answer this question.

Previously, we have developed a methodology that allows fast characterization of diffusion kinetics in Cu/Sn-based bilayer system. We have used the technique to analyze Sn-In system. Understanding other material systems such as Sn-Bi will not only be useful to provide the database in literature, but also as a guideline to develop a model that relate the solder composition and IMC growth rate.

Methodology:
Cu\ Sn_xBi_{100-x} bilayer films will be deposited on transparent glass stripes. Broad composition variation of Sn_xBi_{100-x} will be produced by a combinatorial deposition. Then, these glass stripes will be annealed on a hot plate while monitoring the color change from the back of the glass stripes. Cu has an orange-ish color and transforms to shiny-white when forming IMC. The time required for color change is recorded; Cu consumption rate and therefore the IMC growth kinetics can then be deduced.

Complimentary experiments will be carried out to identify the IMC type and also microstructural evolution.

Equipment:
X-ray diffraction spectroscopy (FACTS laboratory)
Scanning Electron Microscopy/EDX (FACTS laboratory)
In house annealing setup (MRC laboratory)
Sputter deposition machine (Cleanroom)
Surface Profiler (Inorganic Lab)

Remarks:
Student is expected to work independently.

Final Year Project Proposal 6

Project Title:
Frontside sample preparation for failure analysis of ICs

Supervisor:
Assoc. Prof. Gan Chee Lip

Graduate Mentors:
Dr Liu Qing (liuqing@ntu.edu.sg)
Ms Katherine Kor (HBKor@ntu.edu.sg)

Description:
Sample preparation for failure analysis of ICs consists of several techniques. Decapsulation is the first failure analysis step carried out to open a package in order to facilitate the inspection, electrical examination, or chemical analysis of the internal features of the package. Subsequently, if the failure site is at the top metal layers, frontside sample preparation may be required. Materials can be removed with various techniques such as reactive ion etching (RIE), polishing, chemical etching. With the advancement of technology, modern chips and packages are more complicated. Proper sample preparation methods are needed.

In this project, several types of samples will be studied. Different topdown sample preparation methods will be investigated, such as laser decapsulation, semi-automatic acid decapsulation, manual acid decapsulation, or mechanical decapsulation or RIE. The main focus is to avoid the damage to the chips.

Methodology:
The microelectronic chips will be prepared by different techniques. Optical images of the micro-chips will be captured after the sample preparation.

Equipment:
Optical Microscope, Polisher, RIE, Laser decap, Auto decap

Remarks:

Final Year Project Proposal 7

Project Title:
Backside sample preparation for failure analysis of ICs

Supervisor:
Assoc. Prof. Gan Chee Lip

Graduate Mentors:
Dr Liu Qing (liuqing@ntu.edu.sg)
Ms Katherine Kor (HBKor@ntu.edu.sg)

Description:
Sample preparation for failure analysis of ICs consists of several techniques. Decapsulation is the first failure analysis step carried out to open a package in order to facilitate the inspection, electrical examination, or chemical analysis of the internal features of the package. Subsequently, if the failure site is at the bottom metal layers and the chip consists of more than 10 metal layers, it will be much more challenging to gain access from the frontside. Thus, backside sample preparation may be required.

In this project, several types of samples will be studied. Different backside sample preparation methods will be investigated, such as mechanical polishing, semi-automatic acid decapsulation, or RIE. The main focus is to avoid the damage to the chips.

Methodology:
The microelectronic chips will be prepared by different techniques. Images of the micro-chips will be captured after the sample preparation.

Equipment:
Optical Microscope, Infrared Microscope, Polisher, RIE, Laser decap, Auto decap

Remarks:

Final Year Project Proposal 8

Project Title:
Development and characterization of SiO_2 based materials as potential shape memory materials

Supervisor:
Assoc. Prof. Gan Chee Lip

Mentor:
Ms Zeng Xiaomei (XMZeng@ntu.edu.sg)

Description:
It has been reported that certain SiO_2 based minerals can have significant volume change during martensitic transformation. Such transformation can serve as an important mechanism for material to have shape memory property. However, little work has been done in exploring suitable SiO_2 based materials as candidates of shape memory material. Therefore, we are proposing to explore and fabricate suitable SiO_2 based materials that can potentially exhibit good shape memory property.

The scope of the project will include literature work on selecting suitable SiO_2 based system. Selected candidate will be fabricated and characterized to study the morphology, grain size and volume change capability.

Methodology:
Part 1: The student will gain knowledge of SiO_2 based materials that has martensitic transformation by literature working, followed by a selection of material that possesses the required properties as potential shape memory material. The student will also attend training for relevant instruments.

Part 2: The selected system will be fabricated with standard method for bulk ceramic fabrication, including powder mixing, green pellet compacting, sintering at elevated temperature and polishing.

Part 3: The fabricated material will be characterized with instruments and subsequently analyzed with software. The properties such as density, morphology, grain size and phase composition of developed material will be studied. The volume change and temperature for martensitic transformation will be explored.

Equipment:
Instrument: DSC, XRD, FESEM
Software: TOPAS, ImageJ

Remarks:
This proposal is only applicable for student who can start working in early June.

Final Year Project Proposal 9

Project Title:
Synthesis and mechanical properties of Cerium stabilized ZrO_2 nanofibers

Supervisor:
Assoc. Prof. Gan Chee Lip

Mentor:
Dr Du Zehui (duzehui@ntu.edu.sg)

Description:
Zirconia (ZrO_2), as a very important advanced ceramic, has been widely studied because of its unique properties such as high toughness, chemical inertness and excellent refractory properties. However, the reliability of its engineering applications is still being questioned due to the formation of cracks and the resultant failure of performance. The cracks are usually formed along the grain boundaries of ceramics, especially at the triple junctions.

In this work, we are going to develop the ZrO_2 ceramics in one dimension, for example, nanofibers. As these microstructures have very large free surface area (due to their small diameters), comparatively small grain boundary area and lack of triple junctions, they can effectively resist the intergranular fractures. As a result, significantly enhancement on the mechanical properties of ZrO_2 is expected. The as-developed ZrO_2 nanofibers can be the basic blocks to further develop the long-sought super-ductile ceramics.

Methodology:
The ZrO_2 nanofibers will be developed by electrospinning or hydrothermal method in this project. Many cutting-edge characterization tools on nanomaterials, such as FESEM, TEM, XRD, EBSD, FIB and Hysitron nano-indenter systems will be used. The effect of precursors and processing temperatures and steps (etc.) on the microstructure, mechanical properties of the nanofibers will be systematically investigated. And the ZrO_2 nanofibers with excellent strength and toughness will be demonstrated at the end of the project.

Equipment:
Electro-spinner, SEM, XRD

Remarks:

Final Year Project Proposal 10

Project Title:
Electrical characterization of compositional changes in Ag-In solder for harsh environment electronics packaging

Supervisor:
Assoc. Prof. Gan Chee Lip

Graduate Mentor:
Dr I Made Riko (imaderiko@ntu.edu.sg)

Description:
Increasing fuel demand and ever scarcity of the natural resource such as oil had driven efforts to find new oil reserve deep in earth mantel. Deep earth exploration requires a much more reliable instrumentation and sensors that can survive extreme pressure and temperature such as 2000 atm and 300^{o}C, respectively. The high remelting temperature of Ag(rich)-In solder system may be suitable for such an application. However, their electrical properties as a function of compositional are not yet fully understood.

In this project, we will investigate the relation between the In composition and their behavior at harsh environment.

Methodology:
Electrical test structure of Ag_xIn_{100-x} films will be created by co-sputtering deposition of Ag and In on Alumina, Silicon or glass substrates with Ti or W as the adhesion layer. The structure will be defined by metal shadow masks. A compositional variation of Ag_xIn_{100-x} will be produced by a combinatorial deposition. The electrical test structure will then be annealed on a hot plate while the electrical resistance change is being monitored.

Complimentary experiments will be carried out to identify the IMC type and study the microstructural evolution.

Equipment:
X-ray diffraction spectroscopy, Scanning Electron Microscopy
Sputter deposition machine, Surface Profiler, Cross-section sample preparation, In house annealing setup

Remarks: