【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅱ)

Title of Project : Science of Hetero-Interface of Advanced Power Devises in Extreme Environments

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Research Area : Engineering
Keyword : Electrical connection/Wiring, Power devise, Electromigration

【Purpose and Background of the Research】

New power semiconductors such as SiC and GaN enable their operation at extremely high temperature beyond 300 ºC. In such an extreme environment, thermal, mechanical, optical and electronic properties should be precisely designed and controlled by understanding the behavior of each material and each hetero-interface (Fig.1).
In the present work, a design concept of the advanced power semiconductor structure will be demonstrated, which will be derived from the basic idea obtained by understanding and development of heat-resistant/heat-dissipation structure, anti-corrosion/anti-oxidation treatment, electro-migration (EM) and whisker mechanism/ mitigation.

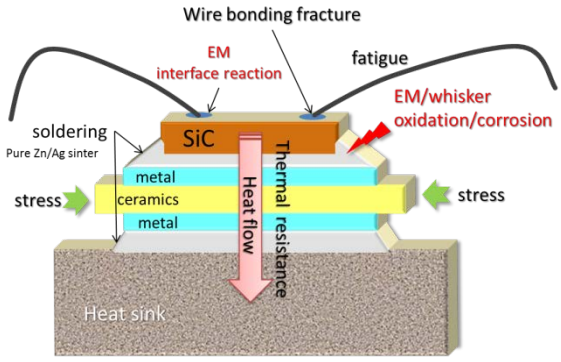

Fig.1 Influencing factors of hetero-interfaces in new generation of power semiconductors.

【Research Methods】

Pure Zn soldering and Ag sinter joining will be adopted to form the devise structure. Through properties evaluation and simulation, the four primary subjects will be promoted as following:
1. Stress relaxation and heat-dissipation: The interconnection structure is evaluated with microstructural and CAE analyses.
2. Anti-corrosion/oxidation design: Inter-connection materials/structure will be designed for 300 ºC operation in air.
3. EM phenomenon: EM mechanism will be analyzed on interconnection/wiring under large current at elevated temperatures.
Whiskering: The mechanism of whiskering under extreme thermal cycling will be clarified and the mitigation method will be proposed.

【Expected Research Achievements and Scientific Significance】

The advanced power semiconductor devises of high reliability will be provided through controlling a hetero-interface structure based on the established design concept. They will be applicable for the devices of high-performance renewable energy conversion, low energy consumption devises, energy efficient hybrid/ electric vehicles/bullet train, the exploring devises for the earth and the universe.

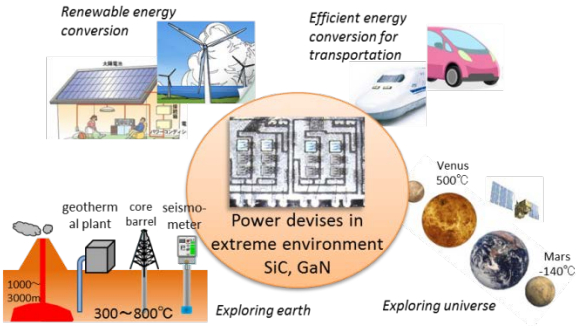

Fig.2 Expected advanced devises.

【Publications Relevant to the Project】

・K. Suganuma, et als, Sn whisker growth during thermal cycling, Acta Materialia, 59[1](2011), 7255-7267.
・K. Suganuma, S. Kim, Ultra heat-shock resistant die-attachment for silicon carbide with pure zinc, IEEE Electron Device Letters, 31[12](2010), 1467-1469.

【Term of Project】 FY2012-2016

【Budget Allocation】 157,800 Thousand Yen

【Homepage Address and Other Contact Information】

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