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October 1, 2008

To Whom It May Concern,

High capacitance density material developed for use as embedded capacitors

AEC-1 results in higher-speed operation of ICs

Mitsui Mining & Smelting Co., Ltd. (Mitsui Mining & Smelting, President: Yoshihiko Takebayashi) has developed an embedded capacitor material called AEC-1 with capacitance density as high as 1 micro farad/cm² that enables ICs to be operated at much higher frequencies.

Since AEC-1 is easily patterned using conventional PCB process, not only will IC packages utilize the material but many other applications will find it advantageous as well. Mitsui Mining & Smelting aims to begin commercialization of AEC-1 within the next several years by developing partnerships with manufacturers in several application areas.

<Embedded capacitors with very high values have not been achieved so far in organic packages>

The newly developed capacitor^(Note 1. below) for embedded use named AEC-1 has very high capacitance density^(Note 2.), 1 μ F/cm²^(Note 3.), which is approximately five-hundred times larger than existing commercially available capacitor material. Testing^(Note 4.) has demonstrated that the material survives under severe environments of high temperature and high humidity without degrading its functioning as a capacitor. Therefore, it provides for the stable functioning of ICs, and contributes to the integration of the next generation mobile devices.

AEC-1 is thin enough to be embedded in a multilayer board. Embedding in the board contributes to lower total cost in manufacturing by reducing surface mounting cost, board area and simplifying manufacturing process. In particular, by embedding right under the ICs, AEC-1 provides sufficient current without generating noise because of the extremely short distance (low inductance).

AEC-1 was developed by harmonizing and utilizing the technologies from other business units of Mitsui Mining & Smelting such as electrodeposited copper foil, its series like conventional embedding capacitor material (FaradFlex[®]), inorganic material and physical vapor deposition. This is a complex material with excellent adhesion strength^(Note 5.) between metal and metal oxide ceramics. The ceramic dielectric layer

(0.6 micron thick) is sandwiched ^(Note 6.) between copper electrode (2-20 micron thick) and Nickel electrode (20 -50 micron thick).

The ceramic dielectric layer consists of environmentally safe materials, and contains no lead.

This unique structure of AEC-1 allows it be patterned on both sides using standard etching processes, which anticipates wide variety of industrial applications in addition to IC packages.

The patents of AEC-1 have already been filed by Mitsui Mining & Smelting.

< **Commercialization through partnerships with companies** >

Mitsui Mining & Smelting will concentrate on the commercialization of AEC-1. In addition to IC packages, a wide range of applications are expected to be developed through partnership with companies interested in embedded capacitor technology. AEC-1 has obtained high regard from various industries and stirred expectations for corporations. Mitsui Mining & Smelting aims to begin its commercialization within the next several years.

Mitsui Mining & Smelting continues constant effort to improve specifications of AEC-1, introducing electrode material of Copper instead of Nickel as an example.

< **Business circumstance and prospect** >

Along with the performance improvement of mobile electronic devices, PCBs incorporating this material is expected to support higher speed signal processing and stable operations of ICs at lower operating voltage. To achieve the objectives of higher performance and reduced size the first options have been the reduction of circuit length by fine patterning, reducing of thickness and increasing the number of fine discrete devices, which has almost reached the limit. The most effective alternative is regarded to be embedding electronic components into the boards as demonstrated by AEC-1. The demand of PCBs with embedded functionality will expand more in the near future.

Mitsui Mining & Smelting has already been selling embedded capacitor material named FaradFlex[®] mainly in the US and Japan. It has the highest capacitance density of commercially available products and has been in high-end telecom and networking applications such as supercomputers and high-performance servers.

AEC-1 will expedite the emergence of new markets as it has much higher capacitance density compared with FaradFlex[®]. Not only for next generation CPUs but every industry which needs thinner products, high-speed processing and multi-functionality.

Note 1. Capacitor ;

One of the components in the circuit, accumulating the electricity.

Note 2. High capacitance density ;

1 μ F/cm² is five hundred times larger than high capacitance FaradFlex[®] BC16T(1.7nF/cm²).

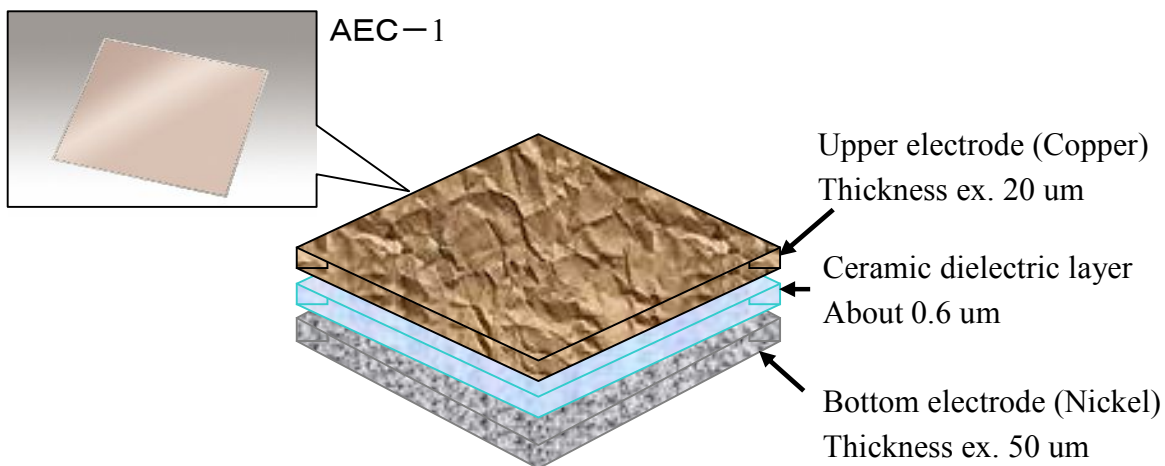
Note 3. $\mu\text{F}/\text{cm}^2$;
It represents electricity accumulated in unit area.

Note 4. Testing ;
For example, AEC-1 exhibited no deterioration even after 1000 hours exposure to temperature of 85 degrees Celsius, 85% humidity and functional under exposure to higher temperature of 130 degrees Celsius, 85% humidity.

Note 5. Excellent adhesion strength ;
The peel strength between metal electrode and ceramic dielectric is more than 0.5kgf/centimeter which satisfies enough to be processed in normal PCB manufacturing.

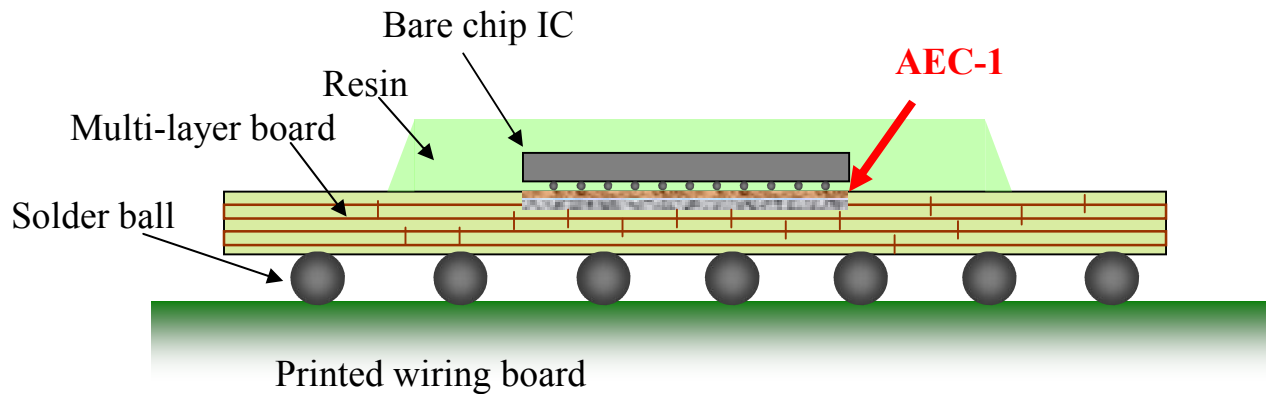
Note 6. Sandwiched ;
See the attached information below.

1. Structure of AEC-1



The thickness of upper and bottom electrode is flexible upon request of customers.

2. Example usage of AEC-1



[For further information on this matter]

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