FinFET with the world's smallest characteristics variability

Contributing to lower power consumption and higher performance of integrated circuits

We have developed a prototype of a 14 nm-generation 3D transistor (FinFET) with the world's smallest variability of characteristics (Fig. 1). A primary cause of the characteristics variability in a FinFET is the variability of physical properties of the metal gate electrode material. An amorphous metal material for the gate electrode that has a small variability of physical properties has been developed and the prototype FinFET was fabricated using the material. The variability of the electrical characteristics for the FinFET with the amorphous metal gate showed better variability than that of the FinFET with a conventional polycrystalline metal gate, and achieves the world's smallest characteristics variability. With integrated circuits beyond the 14-nm generation, including SRAMs, major issues have been the hindrance to performance improvement and the reduction in yields, both due to the characteristics variability of elements. The present results are expected to contribute to solving these issues.

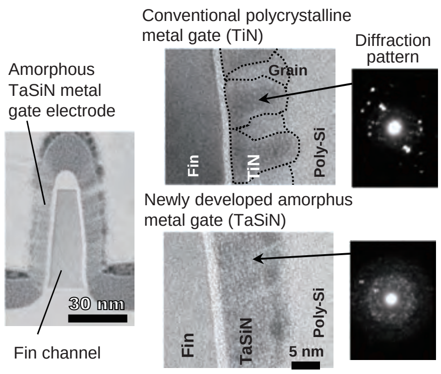

Fig.1 Comparison between the developed FinFET with the amorphous TaSiN metal gate and the conventional FinFET with the polycrystalline TiN metal gate

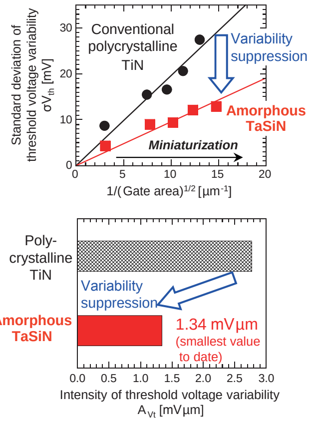

Fig.2 Pelgrom plots comparing the threshold voltage variability of the amorphous TaSiN metal gates and the conventional polycrystalline TiN metal gates

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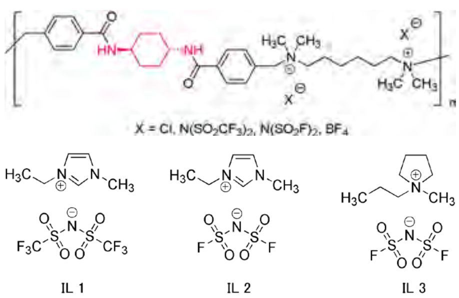
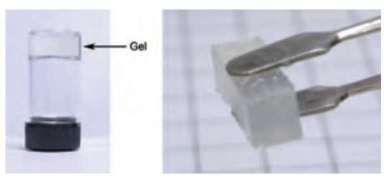
Gel-forming materials for ionic liquids that work at very low concentrations

Additives gelatinizing ionic liquids with excellent retention of their ionic conductivities

Ionic liquids (ILs) are attractive materials because of their unique properties such as low volatility, thermal stability, nonflammability, intrinsic ionic conductivity, and electrochemical stability. ILs are expected as electrolytes in electrochemical devices. The gelation procedure may become a convenient method to obtain conductive quasi-solid electrolytes, which are often preferred in practical applications to avoid electrolyte leakage. We have developed novel gel-forming materials derived from *trans*-cyclohexane-1,4-diamine for ionic liquids. They can gelatinize a variety of ionic liquids at very low concentrations (0.9-20 g/L). The gel-sol transition temperature are greater than 100 ℃ in the concentrations over 50 g/L for IL 2 and greater than 125 ℃ in the concentrations over 20 g/L for IL 3. The gelatinized ILs exhibit high mechanical strength along with the rapid recovery in rheology measurements. In addition, the ILs retain almost their ionic conductivities after gelation.



Structure of the developed gelator (above), and the structure of ionic liquids for the examination (below)



The gel of ionic liquid 1 formed in a mold

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