

Principal Research Results

Application of Aluminum Nitride Spherical Nano-structured Composite Particles to Insulating Material of All Solid Insulated Transformer

Background

One of the most important science and technology fields in Japan is “Nano Technology and Materials”^{* 1}. We have developed technologies for synthesizing nano-particles and composite particles consisting of nano-particles dispersed on the surface of spherical micro-particles^{* 2}. On the other hand, we have proposed eco-friendly compact all solid insulated transformer and have developed an epoxy resin mixed with aluminum nitride (AlN) particles that have high thermal conductivity as an insulating material of all solid insulated transformer^{* 3}.

Objectives

To investigate on an application of the epoxy resin mixed with AlN composite particles to an insulating material of all solid insulated transformer;

Principal Results

The AlN composite particles that have high purity and high degree of circularity^{* 4} were added to an epoxy resin. The thermal conductivity and AC electric breakdown strength of the epoxy resin mixed with AlN composite particles were measured in a room temperature.

1. Epoxy resin mixed with AlN composite particles

TEM observations clarified that nano-particles were dispersed between micro-particles in the epoxy resin (Fig.1). This result caused a higher volume fraction (40%) of AlN composite particles in the epoxy resin than the case of commercial spherical AlN particles.

2. Application of AlN composite particles to insulating material of all solid insulated transformer

The solid line in Fig.2 shows the relationship between thermal conductivity and AC electric breakdown strength that is necessary for an insulating material of all solid insulated transformer. Plotted points in Fig.2 show the presumed values in a high temperature by using the thermal conductivity and AC electric breakdown strength of the epoxy resin mixed with AlN particles of room temperature. From these results, it was concluded that the epoxy resin mixed with AlN composite particles is a promising material that has a high margin for designing all solid insulated transformer^{* 5}.

Future Developments

The particle conditions that have easy-casing ability when mixing with an epoxy resin will be clarified.

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Reference

M. Iwata, et.al., 2006, “Design and evaluation of all solid transformer (Part 4) -Thermal conductivity and breakdown strength of epoxy resin with spherical nano-structured composite particles of aluminum nitride-”, CRIEPI Report H05008 (in Japanese)

* 1 : The second basic plan of science and technology in Japan (March, 2001), The third basic plan of science and technology in Japan (March, 2006)

* 2 : CRIEPI Report W02012 (July, 2003), W02022 (April, 2003), W03022 (July, 2004)

* 3 : CRIEPI Report W01024 (April, 2002), W02024 (April, 2003)

* 4 : The composite particles were synthesized by using transferred type arc plasma. The AlN purity in the particles was higher than 99% so that the thermal conductivity of the epoxy resin mixed with AlN composite particles increases. The degree of circularity of particles was approximately 0.9 so that the electric breakdown strength of the epoxy resin mixed with AlN composite particles increases.

* 5 : “Electrical insulating resin and its production method”, Patent in Japan, No. 2006-81378

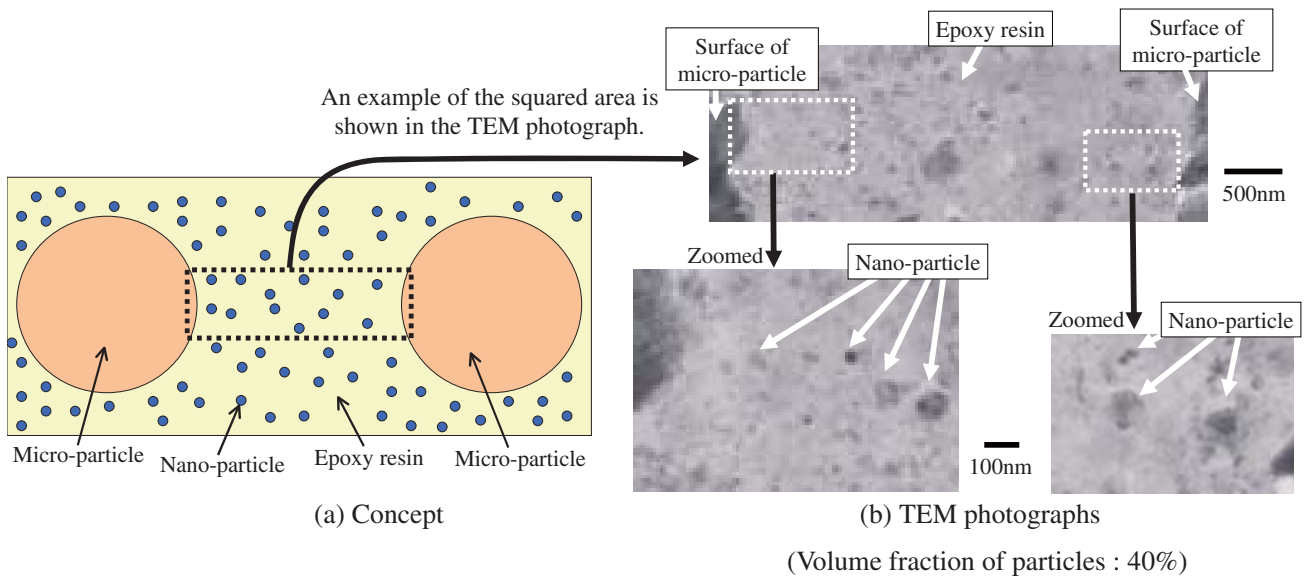
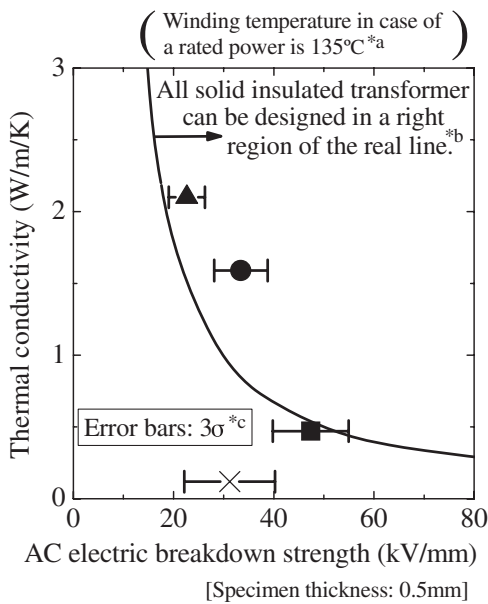


Fig.1 A concept and TEM photographs of an epoxy resin mixed with composite particles

Composite particles in a epoxy resin split to micro-particles and nano-particles.



Plotted points (×, ▲, ■, ●) are presumed values in case of 135°C.

Particles in an epoxy resin			Notes
Kinds	Volume fraction (%)		
×	None (only epoxy resin)	0	*d
▲	Crushed particles (commercial ones)	42.5	
■	Spherical particles (commercial ones)	35	*c
●	Composite particles	40	*c

注^a: Average winding temperature (Class F).

*^b: Calculated region where all solid insulated transformer (275/66kV, 300MVA) can be designed. [CRIEPI Report W02024]

*^c: The values were presumed by using data of room temperature and a temperature dependence of AC electric breakdown strength of epoxy resin mixed with AlN particles.

*^d: Data described in CRIEPI Report W02024.

Fig.2 Relationship between thermal conductivity and AC electric breakdown strength that is necessary for an insulating material of all solid insulated transformer

Epoxy resin mixed with AlN composite particles is a promising material that has a high margin for designing all solid insulated transformer, because it has a good balance between thermal conductivity and AC electric breakdown strength.