DESIGN AND PROPERTIES OF POLYIMIDES WITH ELECTRODEPOSITION ABILITY FOR HIGH PERFORMANCE INSULATORS

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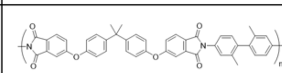
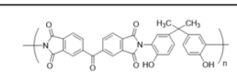
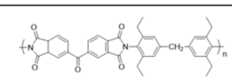
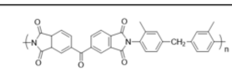
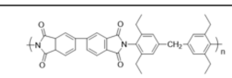
The development of high-performance electric devices has become increasingly important owing to the paradigm shift in energy systems from petroleum to electricity from the viewpoint of sustainable engineering. Thermostable insulating materials with high electric discharge resistance are one of the key technologies for the practical application to the next-generation electric devices such as traction motors for electric vehicles. Therefore, the development of polyimides with facile electrodeposition ability is crucial because they can produce thermostable coatings without any defects on complex-shaped devices.

We have developed several electrodeposition materials of polyimides by a molecular design of introducing ionic moieties in their main chain, such as organic ammonium salts of poly(amide acid)s, and solvent soluble polyimides bearing pendant dimethylamino groups.[1,2)]

We recently discovered that solvent-soluble polyimides with no ionic substituent can be electrodeposited by adding boehmite alumina, with which lifetimes of the polyimide/boehmite alumina hybrid insulating coatings against electric discharge increased by more than 10^4 times than those of the conventional polyimide coatings. Hybrid electrodeposition materials of PI(BPADA/DMB) with boehmite alumina was easily prepared by adding methanol to the NMP solution of PI(BPADA/DMB) in the presence of boehmite alumina comprising 18% of the PI. The zeta potential of the resulting suspension was +38 mV due to the effect of boehmite alumina with large positive zeta potential. The suspension was quite stable after long-time standing. The electrodeposition of the material was performed on a copper plate as a cathode by applying stationary voltage of 250 V because the resulting electrodeposition coatings were not affected by the imposed voltage from 10 V to 250 V. The thickness of the coating layer reached to 63 mm after 10 min electrodeposition. The Coulomb efficiency, 10% weight loss temperature, and the boehmite alumina content of the electrodeposition coating were 28 mg/C, 512 ˚C, and 17%, respectively. When using an electrodeposition material with a boehmite alumina content of 30%, the boehmite alumina content of the electrodeposition coating was 27%. Thus, the boehmite alumina content of the electrodeposition coating relatively corresponds to the original boehmite alumina content in the electrodeposition material. The break down voltage was 6.6 kV, which was obtained by measuring leakage current increasing the implying voltage by 500V/s at AC 50Hz.
Other solvent soluble polyimides can be easily converted to nano sized particles even without boehmite alumina, and their properties and thermostability are listed in Table 1.

Table 1 Properties of electrodeposition paint of polyimide without boehmite alumina and their 10% weight loss temperatures

Polyimides	structure	particle diameter	zeta potential	T_{10} (in N_2)
		nm	mV	℃
PI(BPADA/DMB)		424	−65	508
PI(BTDA/AHPP)		260	−52	405
PI(BTDA/MBDEA)		380	−47	494
PI(BTDA/DMDA)		262	−37	521
PI(s-BPDA/MBDEA)		206	−32	515

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