NASA TECH BRIEF

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Dielectric Films Improve Life of Polymeric Insulators

Polymers that are used as insulators in the construction of capacitors, standoffs, feedthroughs, etc. often are degraded seriously by corona discharges. Coronas are sustained in electric fields established by the potential differences imposed across the surface of an insulator; clearly, any arrangement that reduces the intensity of an electric field will prolong the life of a polymeric insulator.

Degradation of polymeric insulators may be significantly reduced when polymer surfaces are coated with a film that has a gradation of dielectric constants, larger where it is in contact with the polymer and smaller at its exposed surface. A satisfactory film may be prepared by plasma polymerization of the vapor of a monomer such as allylamine or a mixture of a monomer and a diluent gas, for example, a mixture of ethylene and nitrogen. The dielectric constants of successively deposited layers of polymer are determined by parameters such as the type of gas plasma, the partial pressure of the gases in the discharge, the discharge current, and the frequency of the power supplied to the plasma.

The substrate to be coated is supported on a temperature-controlled copper electrode that is mounted in a vacuum chamber; a temperature-controlled counterelectrode is placed a small distance away. The reactor is first evacuated to a background pressure of about 10^{-2} torr; monomer, or a mixture of monomer and diluent is allowed to flow into the reactor, while the pumps are operating, to maintain a preselected pressure in the system. Power is then applied so as to establish a plasma, and the discharge is allowed to continue for the period of time required to deposit a coating of desired thickness. At the end of the period, the flow of monomer is discontinued, the vacuum is broken, and the substrate is removed.

The dielectric constant in successively deposited layers of polymeric films can be caused to vary between a lower value and an upper value by controlling the power supplied to the plasma discharge and maintaining a constant flow of monomer. For example, with allylamine and a plasma operated at 10kHz, the progressive increase of current density from 20 to 113 $\mu A/cm^2$ produced a polymer coating that had a dielectric constant of 5.5 on one side and 7.0 on the other. When mixtures of ethylene and nitrogen were polymerized in a 13.5-MHz plasma, the polymer coatings produced at current densities of 1700 to 6280 $\mu A/cm^2$ and nitrogen partial pressures from 0 to 0.4 torr had dielectric constants ranging from 3.3 to 5.9.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
Reference: B75-10084

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

NASA Patent Counsel
Mail Code 200-11A
Ames Research Center
Moffett Field, California 94035

Source: Martin Hudis and Theodore Wydeven
Ames Research Center
(ARC-10892)

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