ABSTRACT

Commercial aircraft experience a direct hit with lightning, on average, once a year – although the last confirmed commercial plane crash directly attributed to lightning occurred in 1967. This minimal damage experienced by most aircrafts can be attributed to the widespread use of aluminium in construction; it is of course an excellent electrical conductor. Unfortunately there are costly drawbacks associated with metallic designs, such as deleterious effects of fatigue and corrosion. These problems may be overcome by the use of composite materials, which have key advantages including: improved corrosion and fatigue resistance; increased design flexibility; and perhaps most importantly; weight reduction, giving improved fuel efficiency.

The expanding use of composite materials for use in aircraft structures has resulted in new challenges to ensure adequate lightning protection in the design of new airframes and control systems. Advanced techniques such as metallization of exterior surfaces or fine metal wires co-woven into carbon fibre composite skins are used to provide adequate conductivity for lightning currents.

In this project I is proposed to move away from the use of heavy metals completely and impart electrical conductivity to the composites using carbon materials. They would be dispersed in the composite in a similar mesh-like fashion. Carbon nanographite is considered to be the ideal reinforcing material due to its high mechanical strength and aspect ratio, light weight and high electrical conductivity – all achieved with a few weight percent. In addition, carbon nanotubes, carbon black and intrinsically-conducting polymer systems are also considered. In order to further enhance the conductivity of the composite it was decide to dope the polyethersulfone (PES) matrix with a more conductive material; in this case phthalocyanine dye was used.

Experimentally, the nanomaterial is introduced into the thermoplastic polymer (PES, PEEK and PEKK are considered) using different techniques, such as direct blending, solution dispersion and extrusion, with a range of concentrations of nanomaterials

incorporated. In addition, the rheology of the poly(ether sulfone) co-polymer, and the crystallization behaviour of poly(ether ether ketone) was also studied.

In most cases the conductivity was measured using a standard four-point probe technique.

The results from this study highlight a number of key areas required to consider when producing conductive thermoplastic fibres for use with composite technologies.

Declaration