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Development of Durable Textile-Conductive Polymer Composites.

A thesis presented in partial fulfilment of the requirements for the degree of

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Abstract.

The research described in this thesis investigated a range of techniques for the *in situ* polymerisation of thiophene-based intrinsically conductive polymers (ICPs) on textile substrates. Following a review of the literature, three potentially useful techniques were identified; a simple aqueous technique; a vapour phase technique; and a two-stage impregnation technique. The literature also indicated that thiophene-based ICPs were likely to be more durable than those prepared from other precursors.

The aqueous technique proved unsuccessful, but both the vapour and two-stage impregnation techniques were used to prepare textile-ICP composites using 2,2'-bithiophene and 3,4-ethylenedioxythiophene (EDOT). Polymerisation was effected by chemical oxidation of the precursor, with iron (III) salts being the best oxidants. The main drawbacks of the vapour system were the long vapour exposure times (e.g. several days) and/or elevated temperatures required to polymerise these relatively unreactive precursors. Two-stage impregnation was somewhat messy and inefficient, so a novel refinement of the technique (referred to as 'single dip') was developed. With this system, the specimen was impregnated with both precursor and oxidant from a single solution, then removed from the solution and the solvent allowed to evaporate. It was only at this stage that polymerisation occurred, and when more reactive ICP precursors (such as pyrrole) were used, polymerisation tended to occur in solution, and was less effective.

The influence of various treatment parameters was established, while tests confirmed that the deposited ICP layer had no detrimental effect on the desirable fabric properties of flexibility and strength. Composites with surface resistance as low as 65 Ω /square were prepared with less than 6% ICP load on the textile (perchlorate-doped poly(EDOT)). The durability of poly(EDOT) composites was far better than polypyrrole under ageing in ambient conditions, accelerated ageing at elevated temperatures, and when given a treatment that simulated laundering. Finally, a scheme for continuously depositing ICPs onto textiles by this approach was designed, as a way of demonstrating the potential for scale-up of the system.

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