COATED CARBON FIBRE BATTERY HALF-CELLS FOR STRUCTURAL BATTERY COMPOSITES

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1 General Introduction

The paper addresses a method to realise lithium-ion batteries by electrografting of a very thin solid polymer electrolyte (SPE) coating on to carbon fibres. Carbon fibres featuring very high reversible capacity [1] were prepared to be employed as the negative electrodes in a novel structural battery device. A lithium-ion conductive, electrically insulating, polymer electrolyte [2, 3] with an average thickness of 470 nm was deposited around individual carbon fibres by cathodic electrografting [4]. In the paper, an electrocoating procedure applied on carbon fibre yarns, generating dense pinhole-free SPE coatings on individual carbon fibres, in presence of a lithium salt as supporting electrolyte is presented and verified by microscopy. The coated fibres were employed in a novel battery concept paving the route towards a fully structural battery composite material.

2 Coating of carbon fibres

Fibres were coated with a solid polymer electrolyte from a Methoxy polyethylene glycol (350) monomethacrylate (SR550) monomer. For the coating a monomer solution electrolyte containing Lithium triflate salt and a DMF solvent was employed. Fibre coating was performed in a purpose built Teflon setup with a three-electrode assembly, schematically illustrated in Fig. 1. The working electrode consisted of a carbon fibre tow consisting of approximately 3,000 fibres. A CF bundle containing 24,000 fibres was used as counter electrode and a piece of lithium metal as reference electrode.

Fig 1. Schematic of the purpose-built coating rig.

The uncoated and coated fibres are depicted in Fig. 2, below.
Fig 2. Uncoated (upper) and SPE-coated IMS65 fibres.

An average coating thickness of 470 μm was determined by TGA. The Li-ion concentration in the coating was determined to 13%, which is sufficiently high to allow the coated fibre to operate in a battery [3].

3 Battery performance

The coated carbon fibres were employed with slurry containing nano-sized cathode materials and carbon black to form a battery. Cycling data for the carbon fibre battery are shown in Fig. 3.

Fig 3. Cycling of the carbon fibre battery. Five cycles at 1C.

References