AUTOMATED CHARGE PLACEMENT FOR STRUCTURAL MOLDING COMPOUNDS

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ABSTRACT

Details are presented of an automated process for manufacturing net-shape charges for compression molding, using a spray deposition technique. The process is suitable for producing large components (>1m^2) at medium volume levels (1,000-10,000ppa), using low cost, discontinuous fibers. The system has the potential to provide high degrees of automation, high precision in fiber placement (including aligned fibers), low cycle times and low material wastage; offering cost savings over competing preforming/liquid molding routes.

This paper presents results from an experimental study, which focuses on maximizing the mechanical performance of parts manufactured using the net-shape charge approach. A range of structural parameters are studied to facilitate the production of deep drawn components. Test coupons are produced on vertical tooling plates to demonstrate the level of adhesion provided by the sprayed epoxy. Quasi-static tensile properties are presented, which are benchmarked against commercial carbon fiber molding compounds.

1. INTRODUCTION

1.1 Background

Discontinuous fiber reinforced composites account for over 80% of composite materials used within the automotive industry [1], due to their versatility in properties and relatively low manufacturing costs. Material and processing costs of discontinuous fiber composites can be up to two orders of magnitude lower than for pre-impregnated textile composites [2], and through efficient design, can potentially replace woven fiber architectures with almost no reduction in performance [3]. At high volumes (>20,000ppa), discontinuous molding compounds have evolved from cosmetic, glass/polyester materials to advanced structural derivatives consisting of carbon/epoxy. These materials have been used extensively in the automotive industry [4-6], and more recently in the first aerospace application [7] – offering a 50% weight saving compared with aluminum [8]. Advanced molding compounds are essentially manufactured from chopped UD prepreg [9, 10], which inflates the material costs because of the additional intermediate processing. Furthermore, mold design can prove difficult, especially for complex 3D parts because of the material's high fiber loading. It is important to prevent flow lines forming within critical stress regions, as these can seriously compromise the mechanical properties [11]. High areal coverage of the tool (~95%) is thus required to restrict the amount of flow, but this can inevitably lead to large amounts of touch labor to position the charge, increasing cost and cycle times.