

# 博士論文 (要約)

## **Effect of multilayer structures on press forming of CFRP and CFRP/metal hybrid composites**

(CFRP および CFRP/金属ハイブリッド複合材料のプレス成形への積層構造の影響)

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Social demands are promoting forming technologies of lightweight parts. The shape potential of carbon fiber reinforced plastic (CFRP) is nearly limitless and most pronounced advantages over metal is ability to a given application leading to efficient material application. Press forming of CFRP sheets is a newly technique for forming CFRP laminate where CFRP prepreg sheets are fabricated by a sequence of stacking, autoclave of curing process and final press forming. The formability of CFRP laminate is enhanced applied to conventional press forming such as drawing, punching, stamping, etc. Aiming to perform the press forming of CFRP laminate, thus it is important to understand the laminate fabrication process, fundamental mechanical properties of CFRP, and material behaviors in deformation due to press forming. This dissertation presents studies on the press forming of CFRP and its application, CFRP laminates made with standard and thin-ply prepreg thicknesses, individually. Three research topics are carried out in this dissertation:

- 1) Development of new high-performance multilayer CFRP sheets and implementation on drawing of multilayer CFRP laminates: Two notable laminates for the approximately 1400 MPa strength and 30% elongation of laminated CFRP composites were developed by fabricated with standard and extremely thin-ply prepreg layers. Also, elliptical cup drawing was achieved using the laminated CFRP sheets above its glass transition temperature.
- 2) Punching of CFRP laminates and CFRP/metal hybrid composites, investigated their punch-shear performances with varied prepreg thicknesses: Punching resistance ( $K_s$ ) was employed to index the influence on the shear behavior of CFRP and

CFRP/metal hybrid composites under different prepreg thicknesses. Tensile results and  $K_s$  value subjected to standard and thin-ply laminates have been characterized. Further, punching a through-hole on sandwiched laminates and CFRP/metal hybrid composites were proposed for functional use, it provides a wide field of industrial applications.

- 3) Stamping of hybrid CFRP structure with U-shaped section: A combined composites to be fabricated for stamping of hybrid UD standard/thin-ply CFRP laminates as well as compare to the performance on the hybrid structures have been proposed. With this approach, the way of cured join CFRP laminate with thin-ply prepreg which was embedded to the standard layers in order to inhibit the crack growth. Subsequently, the mechanical properties of hybrid composites to be evaluated and compared with the standard and thin-ply laminates. Moreover, performing hybrid standard/thin-ply CFRP composites by stamping of a characteristic shallow tunnel for conducting the three-point bending test on observation of energy absorption will be completed. This finding is critical to the industries sustainable design of complex hybrid body structures with local cost reduction.