2019年度精密工学会 高城賞 受賞

平和産業株式会社は、令和２年３月１８日（水）「２０１９年度精密工学会高城賞」を受賞しました。

受賞論文：「Application of a novel woven metal wire tool with electrodeposited diamond grains for carbon fiber reinforced plastics core drilling, Precision Engineering, 56 (2019) pp.386-394. 」

受賞概要：本賞は精密工学分野で独創性に優れ、工業的価値が高いと認められる論文で、その内容が産業界主体で実施されたものを対象とし、精密工学の基礎技術分野での産業界の活動を促進することを目的として贈賞されるものである。

Precision Engineering 56 (2019) 386–394

Contents lists available at ScienceDirect

Precision Engineering

journal homepage: www.elsevier.com/locate/precision

Application of a novel woven metal wire tool with electrodeposited diamond grains for carbon fiber reinforced plastics core drilling

Koki Suzuki[a], Rei Koyasu[a,b], Yukihisa Takeda[c], Hiroyuki Sasahara[a,*]

[a] Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology, 2-24-16 Nakacho, Koganei, Tokyo 184-8588, Japan
[b] Heiwa Sangyo Co., Ltd., 1-1544-10, Kajita-cho Minami, Funabashi, Chiba, Japan
[c] Nissiex Corp., 184 Komukae, Chuugun, Takasyo-cho, Aichi, 470-2343, Japan

ARTICLE INFO

Keywords:
CFRP
Drilling
Chip
Delamination
Surface roughness

ABSTRACT

Drilling into carbon fiber-reinforced plastics (CFRP) with conventional tools often results in defects like delamination, fiber pull-out, etc. In order to achieve high-quality CFRP hole machining, we developed a new woven metal wire tool (WMW tool) based on core drilling, with electrodeposited diamond grains. Using this tool, we conducted 20-mm diameter core drilling on a CFRP plate with grinding fluid supplied from the inner side of the WMW tool at the grinding point. The new tool also removes chips easily. The method produced high-quality holes without delamination or burr at the entry or exit at a practical feed rate of 100 and 300 mm/min. Although wear was observed on the tip of the wire mesh, new diamond grains appeared at the tip, so that the tool exhibited a self-sharpening effect. The newly developed MWM tool achieved a drastic reduction of chips and superior machined surface at the same time in CFRP drilling.

1. Introduction

Carbon fiber reinforced plastic (CFRP) is widely used in the aerospace industry due to its high specific strength and elastic modulus [1]. Due to an expected growth of around 14% annually in the aerospace and defense market, the demand for CFRP is anticipated to be 23,000 tons by 2020 [2].

1.1. Environmental impact of CFRP machining

In order to assemble CFRP parts, a large number of holes must be machined in the material. In general, these holes are machined by twist drill, but this method generates a large amount of CFRP chips. Chips generated by CFRP cutting become dust, which may have health hazards. Haddad et al. showed that the size of chips generated by CFRP cutting is much smaller than the theoretical size considering the cut depth [3]. Frequency distribution of the size is concentrated in the range of 0.25–1 μm. Dust particles of this size can easily reach the lungs. When cutting CFRP, use of a vacuum system and dust masks are recommended. To reduce health damage, it is also necessary to reduce the amount of chips generated.

On the other hand, research on CFRP recycling has recently advanced. Howarth et al. measured the energy consumption when CFRP was cut with a milling machine [4]. They then modeled the energy required for the mechanical recycling of CFRP using the obtained energy consumption data. Li et al. also compared the cost of mechanical recycling of CFRP with that for its disposal by conventional landfill [5]. They found that in order to lower recycling costs, the carbon fiber recovery rate must be close to 100%. Recycling of CFRP is gradually progressing from pilot studies to industrial scale [6]. It is therefore crucially important to collect as many chips as possible from CFRP machining.

1.2. Recent research on CFRP drilling and study objective

CFRP is regarded as a difficult material to machine, as it causes significant tool wear and undesirable drilling-induced delamination [7]. Currently, polycrystalline diamond (PCD) drills are used for drilling CFRP in order to extend tool life; these tools are, however, very expensive [8].

Tsao and Hocheng presented an analytical model for the delamination caused by tool wear of twist drill in drilling CFRP [9]. They showed that delamination tends to occur because the thrust force increases with the wear of the drill chisel. They also showed that the feed rate affects delamination, and that it can be suppressed by decreasing feed rate, even with worn tools.

On the other hand, drill shapes also play an important role in machining efficiency and the quality of holes. Hocheng and Tsao

* Corresponding author.
E-mail address: sasahara@cc.tuat.ac.jp (H. Sasahara).

https://doi.org/10.1016/j.precisioneng.2019.01.007
Received 17 January 2019; Accepted 20 January 2019
Available online 25 January 2019
0141-6359/