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ScienceDirect

Procedia Manufacturing 21 (2018) 518–524

Procedia MANUFACTURING

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15th Global Conference on Sustainable Manufacturing

Wear reduction on cutting inserts by additional internal cooling of the cutting edge

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Abstract

Modern developments of functional components result in increasing demands on new materials and their characteristics. One potential approach to raise the functional performance of components and products is the application of material combinations in the field of mechanical engineering. Due to the higher complexity of machining material combinations, the challenges concerning the cutting tool's wear resistance and higher lifetime are increasing.
The aim of this work is to demonstrate efficient machining of wire-arc-sprayed cylinder walls of engine blocks out of casted aluminium alloys. This special kind of machining application was realized by the use of thermally stabilized cutting inserts. The cutting inserts are modified with cooling channels by EDM machining in order to apply internal cooling of the tool. This results in less wear and therefore longer tool life.

Peer-review under responsibility of the scientific committee of the 15th Global Conference on Sustainable Manufacturing (GCSM).

Keywords: material combination; simultaneous machining; internally and externally cooled cutting insert; flank wear; notch wear

1. Introduction

Cylinder running faces of modern engine blocks are composed of a material combination, consisting of casted Al-alloys (EN AC-46000, 80 HV) and wire-arc-sprayed cylinder walls (DIN EN 10016-2, 850 HV). Due to the different material characteristics, varying chipping behaviour and some other distinctive material-related effects occur. The large difference in hardness of the materials results in a significant discrepancy in the cutting forces and different wear

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2351-9789
Peer-review under responsibility of the scientific committee of the 15th Global Conference on Sustainable Manufacturing (GCSM).
10.1016/j.promfg.2018.02.152

patterns on the cutting area. This is further accompanied by built up edge at the aluminium cutting area and notch wear at the cutting area of the wire-arc-sprayed cylinder wall. The latter is caused by mechanical and thermal overload [1].

Assemblies can be distinguished in pseudo hybrids and real hybrids (Figure 1, left side). While pseudo hybrids are composed of a support structure out of one material and a non-support structure consisting of another material, real hybrids have a support structure made of different materials. Individual components are distinguished in composite materials (macroscopically homogenous) and material combinations (two or more macroscopically different materials; Figure 1, right side).

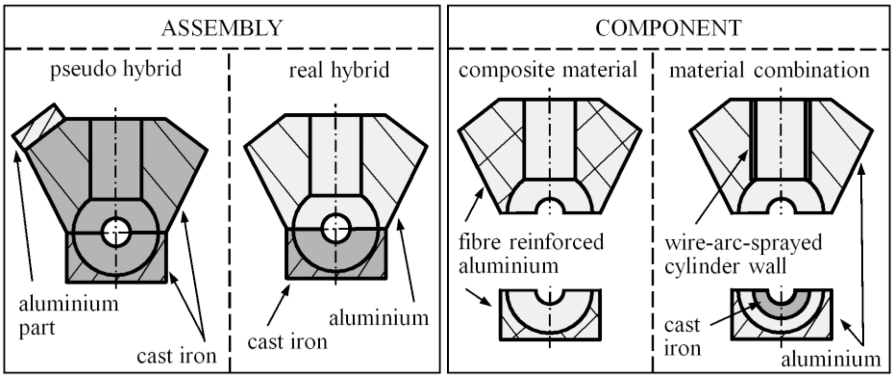

Fig. 1: Definition of assembly and component (cf. [2]).

Moreover, the machining of material combinations can be subdivided with respect to the position of the different materials to the feed vector. Thus, it can be distinguished between serial machining (the process may be optimized for each material – Figure 2, left side), parallel machining (materials are machined alternately in one single rotation, so the process cannot be optimized for each individual material – Figure 2, right side) and simultaneous machining (combination of serial and parallel machining – Figure 2, centre). In the following experiments, the wire-arc-sprayed cylinder wall of aluminium engine blocks will be machined according to Figure 2 with simultaneous machining.

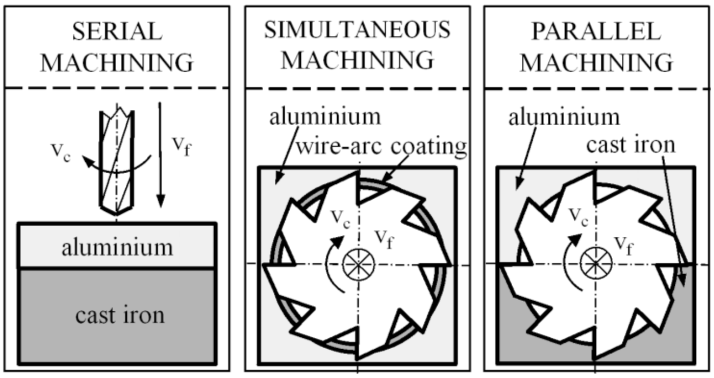

Fig. 2: Definition of serial, parallel and simultaneous machining (cf. [2]).

Based on the fundamental work and model-based simulations in [3], this paper presents additional findings on the influence of different coolant supply solutions for simultaneous machining of wire-arc-sprayed cylinder running faces.