Engineering Failure Analysis 18 (2011) 1527–1537

Contents lists available at ScienceDirect

Engineering Failure Analysis

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

# Blanking punch life improvement by laser cladding

Matej Pleterski, Tadej Muhič *, Bojan Podgornik, Janez Tušek

*Faculty of Mechanical Engineering, University of Ljubljana, 1000 Ljubljana, Slovenia*

ARTICLE INFO

*Article history:*
Received 23 March 2011
Received in revised form 17 May 2011
Accepted 18 May 2011
Available online 30 May 2011

*Keywords:*
Laser cladding
Tool steel
Punch
Sliding wear test

ABSTRACT

The AISI D2 tool steel samples and punches were laser cladded with the application of various laser pulse shapes, preheating and cryogenic treatment. The samples were subjected to metallographic observations and sliding wear test and the punches were inserted into the stamping tool and subjected to real operation. The results suggest that the laboratory tests by themselves are not decisive for the prediction of refurbishment wear behavior or failure. The claddings made by A and B pulses exhibited solidification cracking and failed in a punch application test, although their wear results were comparable with the others or even better. The C-type claddings could all be employed for punch refurbishment with the advantage of preheating to mitigate the interpass HAZ cracking. The preheated and cryogenically treated cladding has shown superior edge stability, smooth and ductile wear behavior and moderate interpass cracking.



## 1. Introduction

Punching tools are subjected to high cyclic loading during the operation, which significantly affects the lifetime of a tool. The factors influencing it can be divided into two groups, based on wear and fracture mechanisms. Tool lifetime can be prolonged by creating proper relations between contact fatigue strength, hardness and toughness. Only a few authors have systematically investigated the mentioned relations that affect cold work tool degradation. The influence of microstructure and carbide morphology on mechanical properties of such steels were researched by Fukaura et al. [1] and Yokoi et al. [2]. It was proven that the carbides were usually responsible for crack initiation and that the critical stress for crack initiation lowered with the carbides being bigger. On the other hand, the carbides significantly influenced the wear resistance of tool steels [3]. However, the aim of many researchers is to improve or make a material with relatively small carbides, uniformly dispersed in the matrix. This is hardly achievable by conventional casting and heat treatment, but can be more easily realized with powder metallurgy and spray forming [4] or application of laser technologies and cryogenic treatment (CT) [5–7] as a support to conventional methods.

Recently, the use of FGM (Functionally Graded Materials) principle has come in the forefront, where the materials are being made in a way to correspond to the expected type of loading. Although these techniques yield good results, there are only few studies reporting on the use of differently constructed surfaces by laser cladding that could improve the local surface characteristics even more, and lower the initial cost of tools due to the possibility of using lower grade materials for the basis of the tool [6,8,9].

Repair by cladding is a common and standard practice in tooling industries, where the life of vital tool parts can be successfully extended by timely repair of damaged surfaces. Without welding as a repair solution, the alternative is to remanufacture one or several inserts. The main advantages of repair using the cladding procedure are well known: a short down-time and an economic advantage compared to machining a new tool or die part. There is also a broad pallet of filler

* Corresponding author. Tel.: +386 41 742 596.
*E-mail address:* tadej.muhic@gmail.com (T. Muhič).

1350-6307/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.engfailanal.2011.05.010