A R C H I V E S O F M E T A L L U R G Y A N D M A T E R I A L S
Volume 54 2009 Issue 2

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COMPUTED TOMOGRAPHY – A NEW TOOL IN STRUCTURAL EXAMINATIONS OF CASTINGS

TOMOGRAFIA KOMPUTEROWA – NOWE NARZĘDZIE DO STRUKTRURALNYCH BADAŃ ODLEWÓW

The paper brings information on the Computed Tomography, a non-destructive method of monitoring quality of the castings, which is a relatively new technique used in foundry. During initial examinations performed with CT *v|tome|xc* device in Austrian Foundry Institute – Leoben, a AZ91 Mg-base cast alloy was tested. It was stated that the CT method gives non-destructively the same results as the destructive metallographic examination does – Figs 2(a) and 2(b). The CT technique also allows obtaining structure features and defects displayed without overlapping – Fig. 5, and should be helpful when elucidating the reasons of porosity formation in solidifying Mg-base cast alloys.

Keywords: Computed Tomography, Modelling, Mg-Al alloy, Porosity

Praca poświęcona jest zastosowaniu Tomografii Komputerowej (CT) do monitorowania struktury odlewów. W procesie kontroli jakości odlewu stosuje się współcześnie metody badań nieniszczących, spośród których tomografia komputerowa (CT) umożliwia uzyskanie trójwymiarowego obrazu wnętrza odlewu. Zastosowanie tomografii komputerowej w odlewnictwie ma stosunkowo krótką historię; z kolei wysoka cena urządzenia powoduje, iż dostępność tej metody jest jeszcze ograniczona. Celem niniejszego artykułu jest przybliżenie potencjalnemu użytkownikowi metody tomografii komputerowej oraz zobrazowanie jej możliwości na przykładzie badań rozmieszczenia porowatości skurczowej w odlewie. Do badań wytypowano piaskowy odlew stopu na osnowie Mg, AZ91. Badania wykonano przy pomocy urządzenia v—tome—x c, Österreichisches Gießerei – Institut. Leoben – Austria. Wykonane badania wykazały, iż nieniszcząca metoda CT umożliwia uzyskanie identycznego obrazu 2D struktury, jaką uzyskuje się w badaniach metalograficznych (Rys. 2(a) i Rys. 2(b)). Tomografia komputerowa pozwala uzyskać również obraz 3D przestrzennego rozmieszczenia porowatości skurczowej (Rys. 5), bez zjawiska nakładania się obrazów. Metoda CT jest narzędziem, które może wyjaśnić przyczyny powstawania porowatości skurczowej w krzepnących odlewach ze stopów na osnowie Mg.

1. Introduction

Computed tomography (CT) was introduced into practice almost 50 years ago and it was associated mainly with medicine. However, recently the computed tomography has also been widely used in the industry. Generally, it is used in scientific laboratories as a non-destructive method in monitoring the production quality by testing samples. The scheme of the CT device is shown in Fig. 1.

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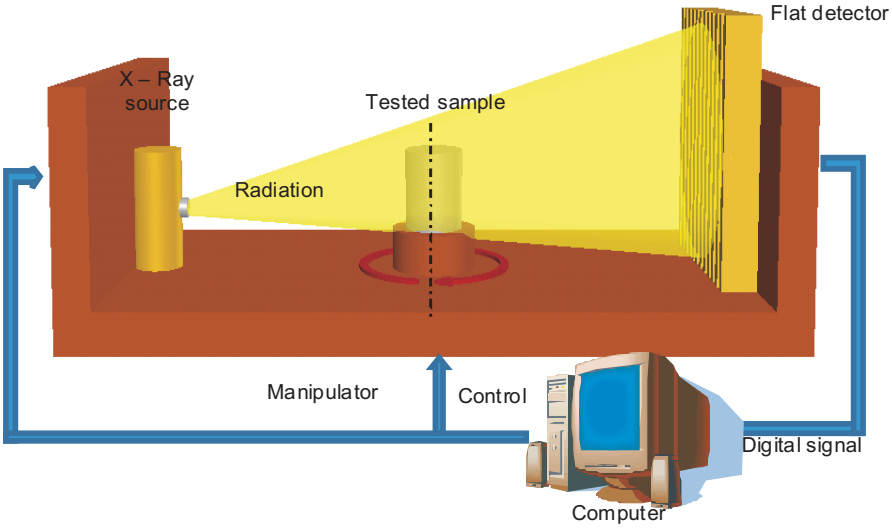
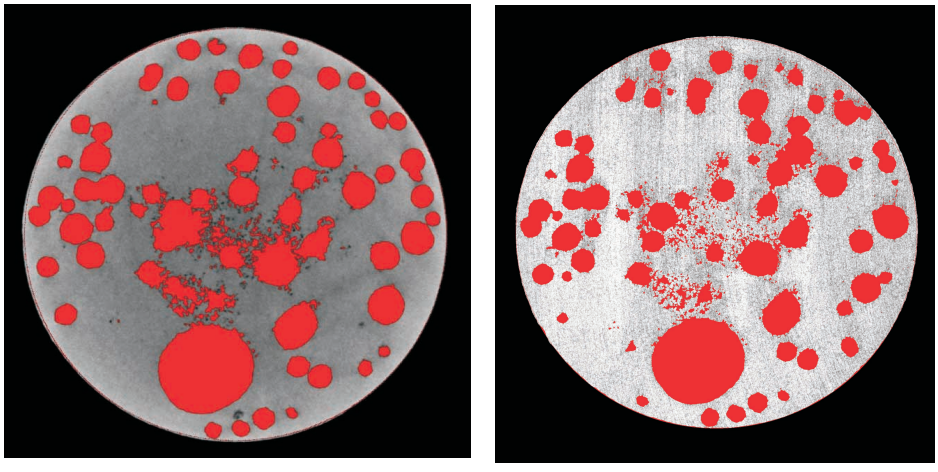


Fig. 1. Schematic sketch of the measuring CT system

The X-ray lamp, usually working at voltage of about 240 kV, is the source of radiation, which is focused on the examined sample, placed on the manipulator table, which makes possible the rotational movement of the examined sample by 360°. During this movement the sample is X-rayed in several hundred steps. The data recorded by the X-Ray radiation digital detector, placed on the opposite side of the examined sample, are stored by a computer. These data allow obtaining a 3D model of the sample, which can be next analysed slice-by-slice to reveal the inner structure of the sample [1].

The CT method can be used instead of the expensive and time-spending metallography examinations – as it is shown in Fig. 2 [2].



(a) **(b)**

Fig. 2. Microporosity according to: (a) computed tomography: 26.8 % and (b) metallography: 26.4 %

2. Results and disscussion

In this initial work the computed tomography was used to examine microstructure and porosity of the magnesium alloy AZ91. The sample Ø4x4 mm tested by CT was cut from the center of the casting. It was also subjected to SEM examinations, which showed microstructure consisting of dendritic primary phase α-Mg (the coarse one, with secondary arms) and eutectics α-Mg+ß-$Mg_{17}Al_{12}$ located in the α-Mg interdendritic regions, Fig. 3. During the presented here initial CT examinations it was stated that the inner defects present in the tested sample are parallel to the casting surface, as it can be seen in Figures 4 and 5.

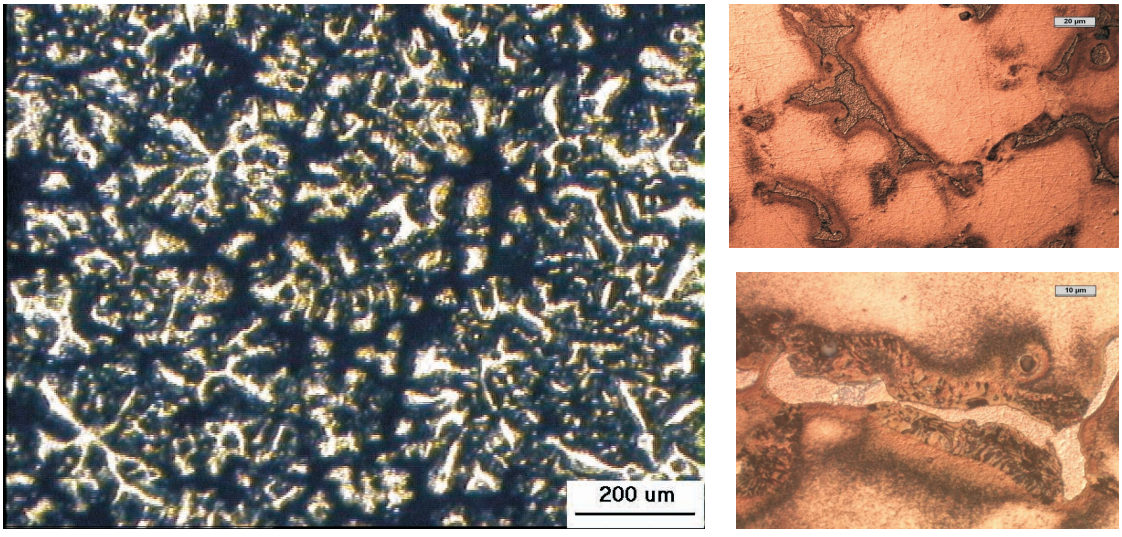


Fig. 3. SEM picture of the examined sample of AZ91 alloy obtained under low (a) and high (b) magnification

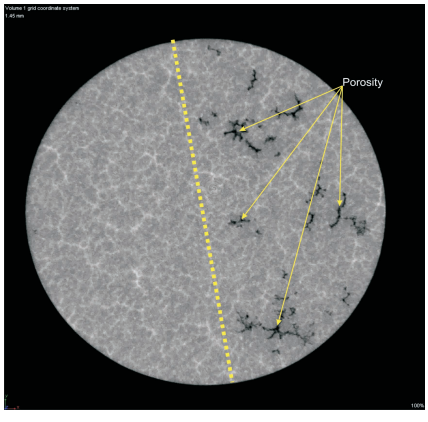


Fig. 4. 2D CT picture of the microstructure and porosity of the AZ91 sample

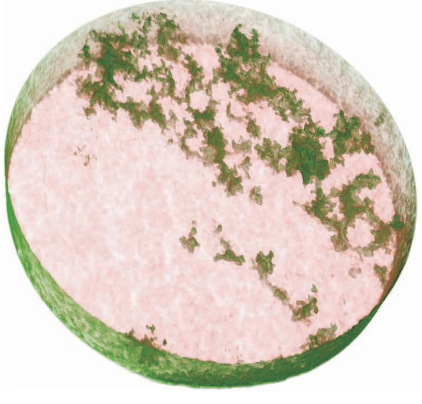


Fig. 5. 3D CT picture of the microstructure and porosity of the AZ91 sample

It is commonly known that AZ91 alloy is prone to porosity and to other defects resulting from the segregation phenomena. The reasons of the microporosity formation in the Mg – Al alloys were the subject of many investigations and discussions, which were started in 1940's. The main subject of these discussions is the question: . . . *is microporosity caused by shrinkage during solidification of the alloy or is it connected rather with the content of dissolved hydrogen*?. . .

This is still under debate and it is believed that using the Computed Tomography can be help-ful in obtaining an answer to this question.

3. Final remarks

The following remarks can be formulated on the basis of the presented initial examinations with the use of CT technique:

– The Computed Tomography (CT) non-destructive technique gives nearly the same picture of the inner porosity defects as obtained during a destructive metallographic examination, which is clearly seen after comparing Fig. 2(a) and Fig. 2(b).
– The CT technique allows obtaining non-destructively both flat 2D picture and 3D picture of the inner structure of the examined sample without overlapping.
– The CT technique can be a useful tool in elucidating the reason of the microporosity formation in the solidifying Mg-base cast alloys. The examinations aimed at this will be published in a close future.

Acknowledgements

The authors acknowledge The European Community for financial support under Marie Curie Transfer of Knowledge grant No. MTKD-CT-2006-042468 (project AGH No. 27.27.170.304) and Polish Ministry of Science and Higher Education for financial support under project AGH No. 22.22.170.7005.

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Received: 10 May 2009.