

Experimental Investigation of the Ce-Mg-Mn Isothermal Section at 450°C via Diffusion Couples and Key Alloys Techniques

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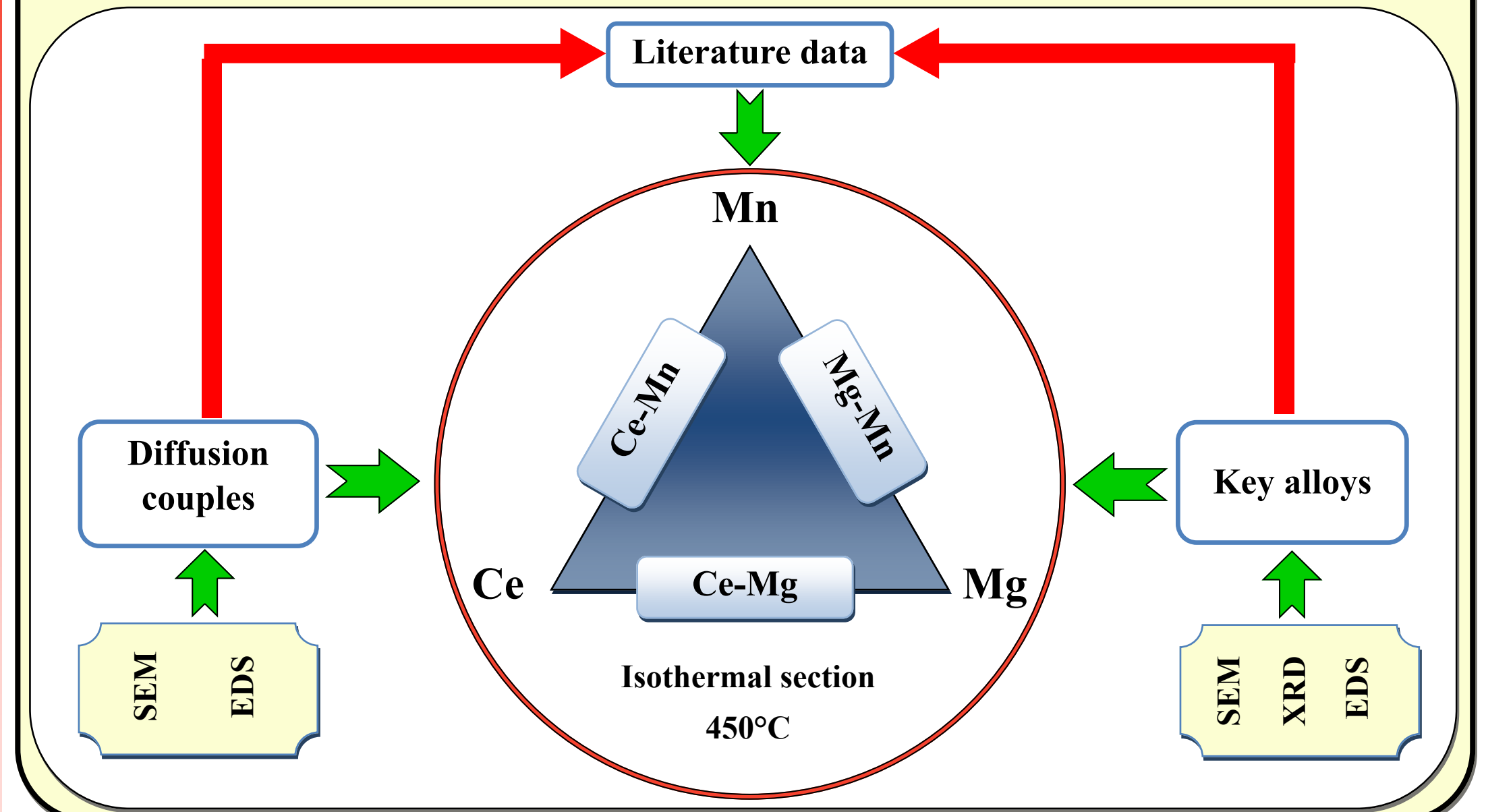
Brief Introduction

The importance of the Ce-Mg-Mn alloys system falls in developing Mg-based alloys that have excellent creep resistance, comparing to pure Mg, at elevated temperature [1]. Thus, addition of Ce enhances the mechanical properties at elevated temperatures, and addition of Mn improves the corrosion resistance. The only available data contain information about two vertical sections [1] and a theoretical liquidus projection predicted by thermodynamic modeling [2].

Objectives

In this work, an experimental investigation of the Ce-Mg-Mn isothermal section at 450°C was performed using diffusion couples and key alloys techniques to provide better understanding on the phase relationships of the system.

Methodology



Experimental Procedure

- The alloys were prepared initially from pure metals (99.95% Ce, 99.98% Mg, and 99.90% Mn).
- The samples were prepared in an electrical arc/induction-melting furnace with water-cooled copper crucible under argon.
- ICP was used for the global chemical composition determination.
- XRD was used to identify the phases, and to find the relative amount of each phase.
- EDS to identify the phases composition.
- Samples were encapsulated under vacuum inside quartz tubes for annealing



Figure 1: Induction-melting furnace

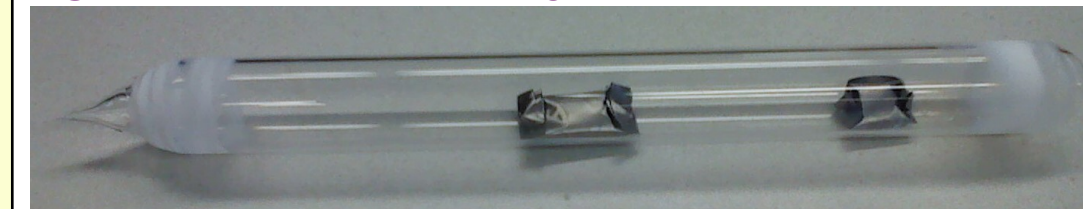


Figure 2: Samples inside a sealed quartz tube



Figure 3: Hitachi S-3400N SEM equipped with WDS and EDS systems for elemental analysis. For more information, please visit: <http://users.encs.concordia.ca/~tmg/>



Figure 4: Clamped and Mounted diffusion couples

Results and Discussion

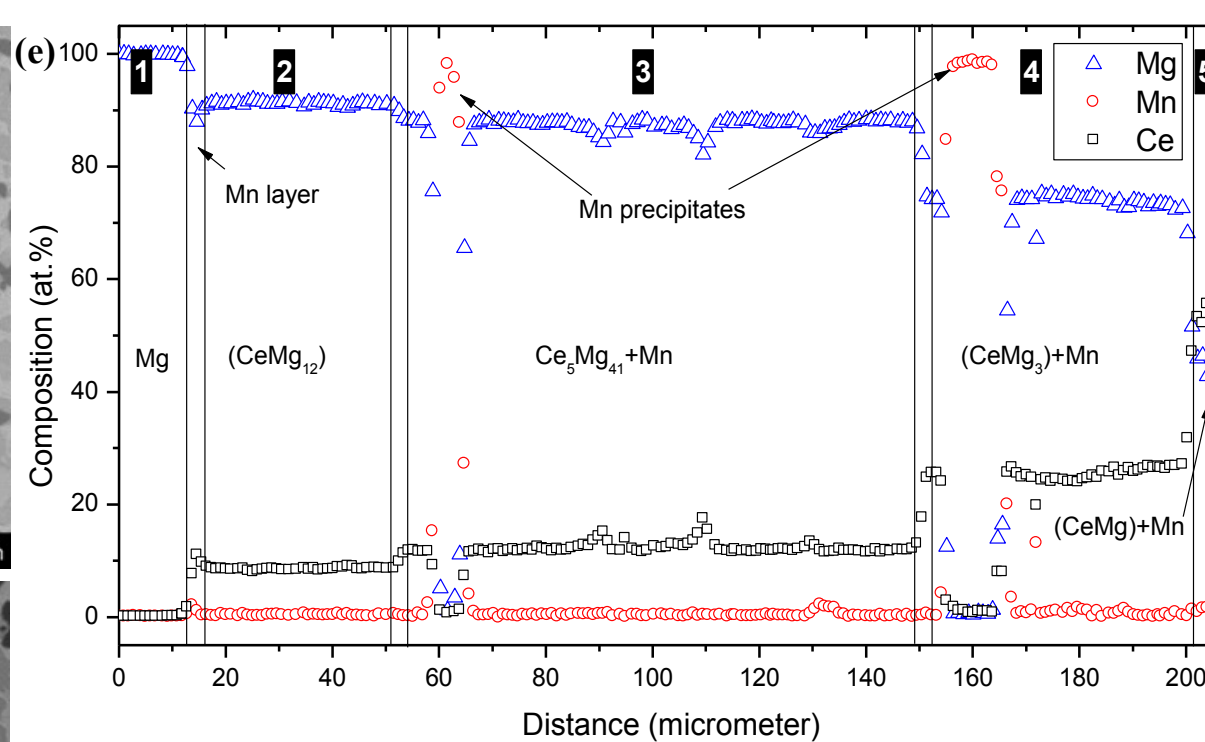
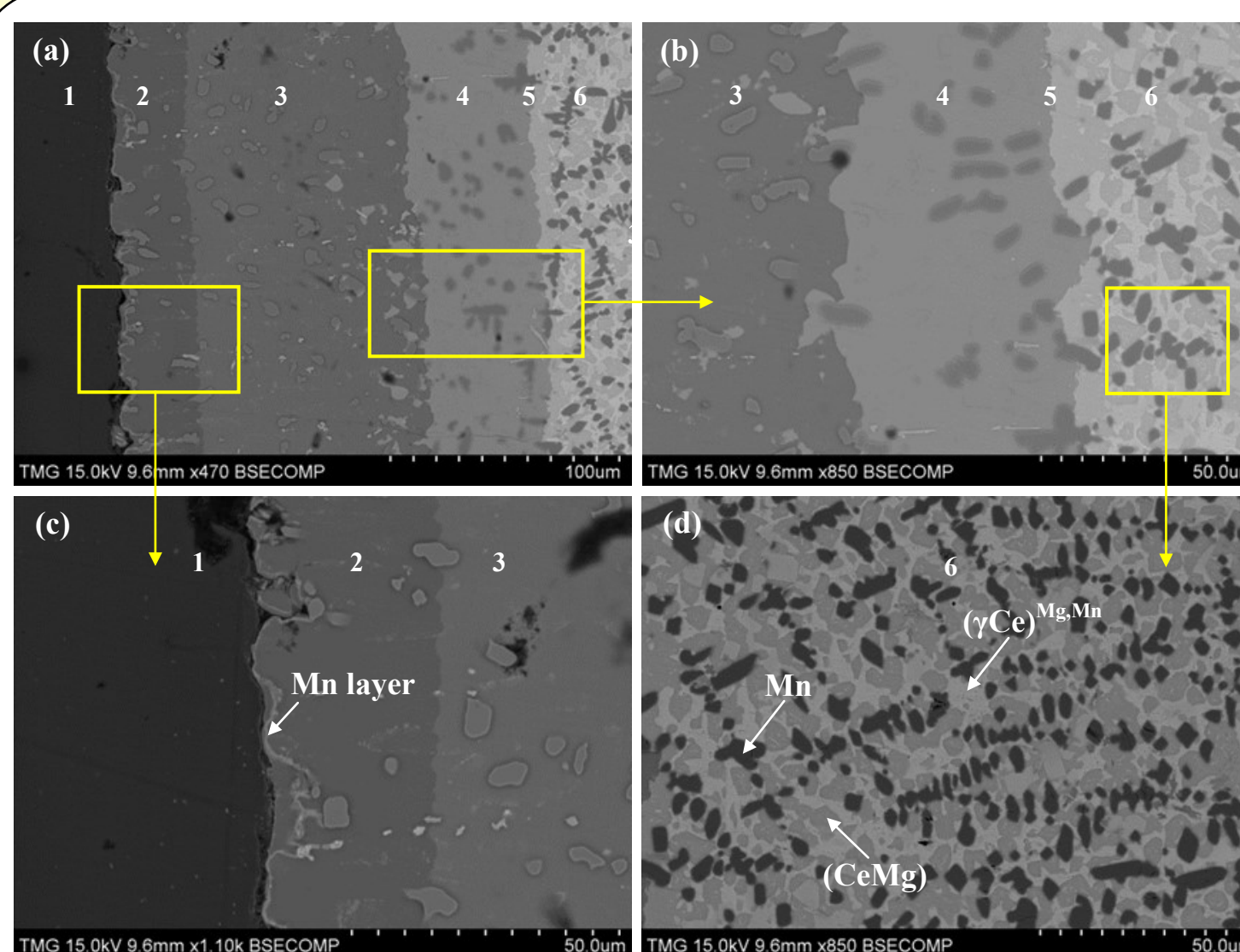


Figure 5: (a), (b) and (c) SEM micrographs of the diffusion zones of diffusion couple #1; (d) Microstructure of sample #2 (52.6Ce-19.8Mg-27.6Mn at.%); (e) Composition profile obtained by EDS line-scan.

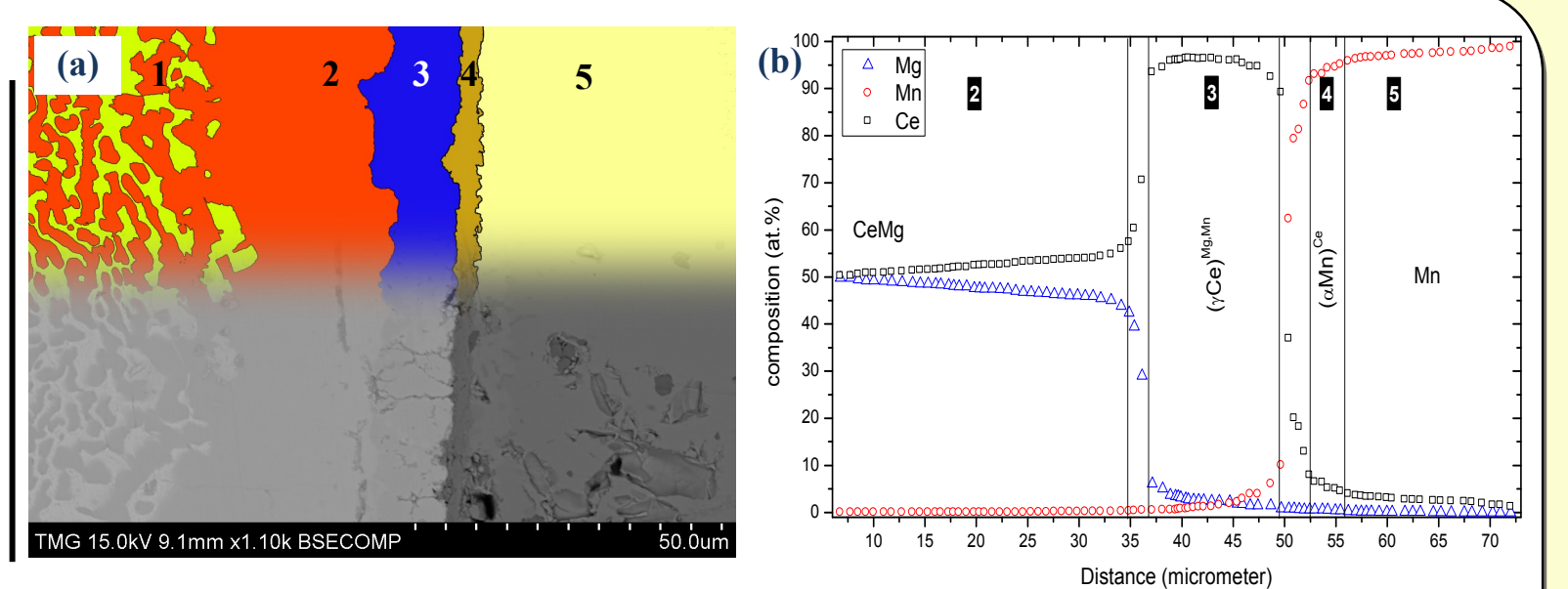


Figure 7: (a) SEM micrographs of the diffusion zones of diffusion couple #2; (b) Composition profile obtained by EDS line-scan.

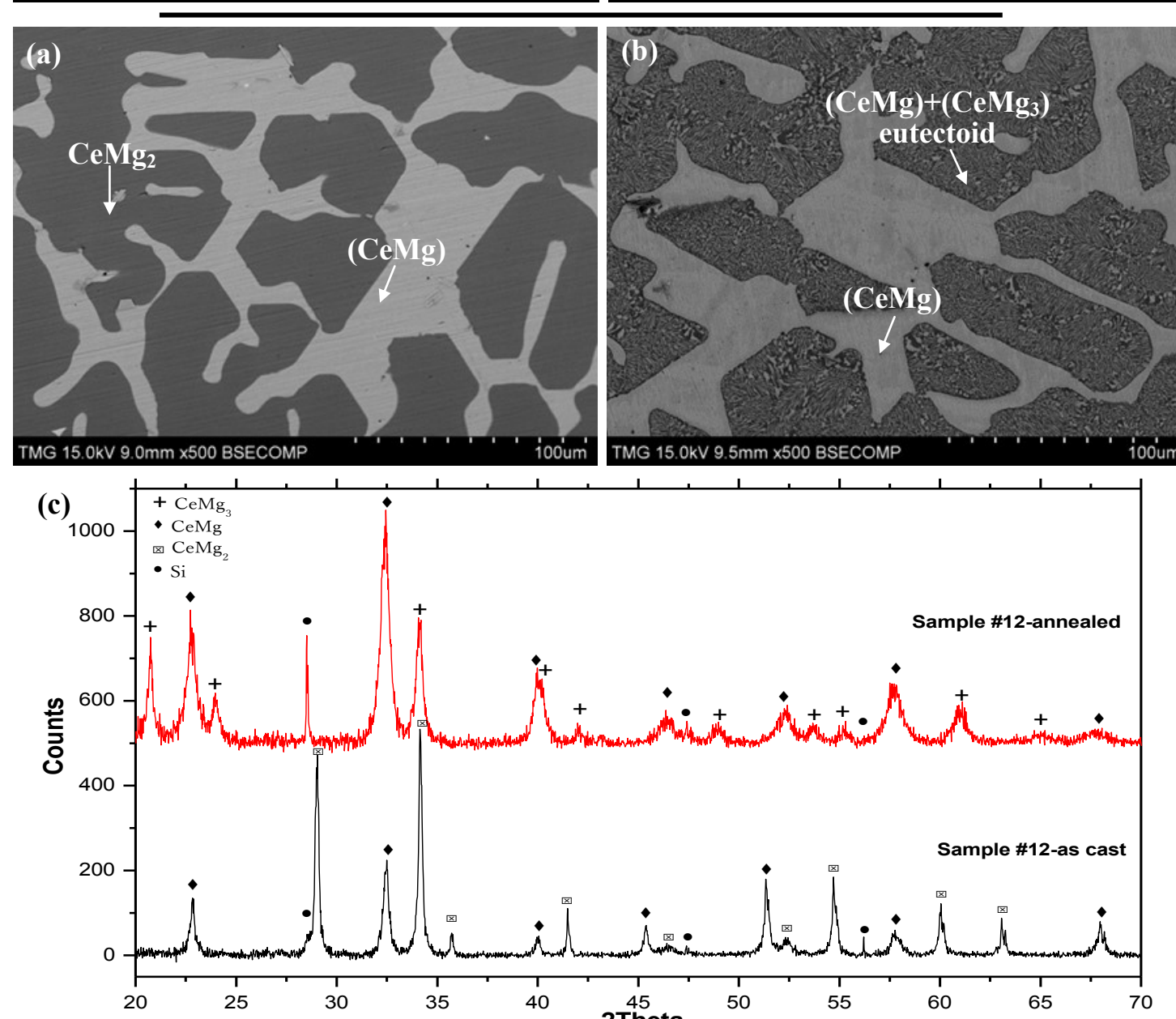


Figure 6: SEM micrographs of sample #12 (a) in the as-cast condition; (b) annealed for 27 days; (c) the as-cast and annealed XRD patterns of sample #12.

Conclusions:

Diffusion couple technique combined with selected equilibrated alloys is used to achieve more reliable information of the Ce-Mg-Mn system. This combination guarantees the accuracy of the obtained phase equilibrium information. In this work, six solid-solid diffusion couples along with 12 key alloys were prepared and studied. Many two-phase regions, composed mainly of Mn and other phase, were observed in the microstructure of each zone. This confirms that Mn source was from the end-members. Hence, the diffusion process occurred due to atomic interdiffusion between Ce and Mg only.

References:

- [1] D. Petrov, et al., Baikov Institute of Metallurgy and Materials Science, vol. 1, pp. 144-147, 1957.
- [2] X. Zhang, D. Kevorkov, I.-H. Jung, and M. Pekguleryuz: J. Alloy. Compd., 2009, vol. 482, pp. 420-28.

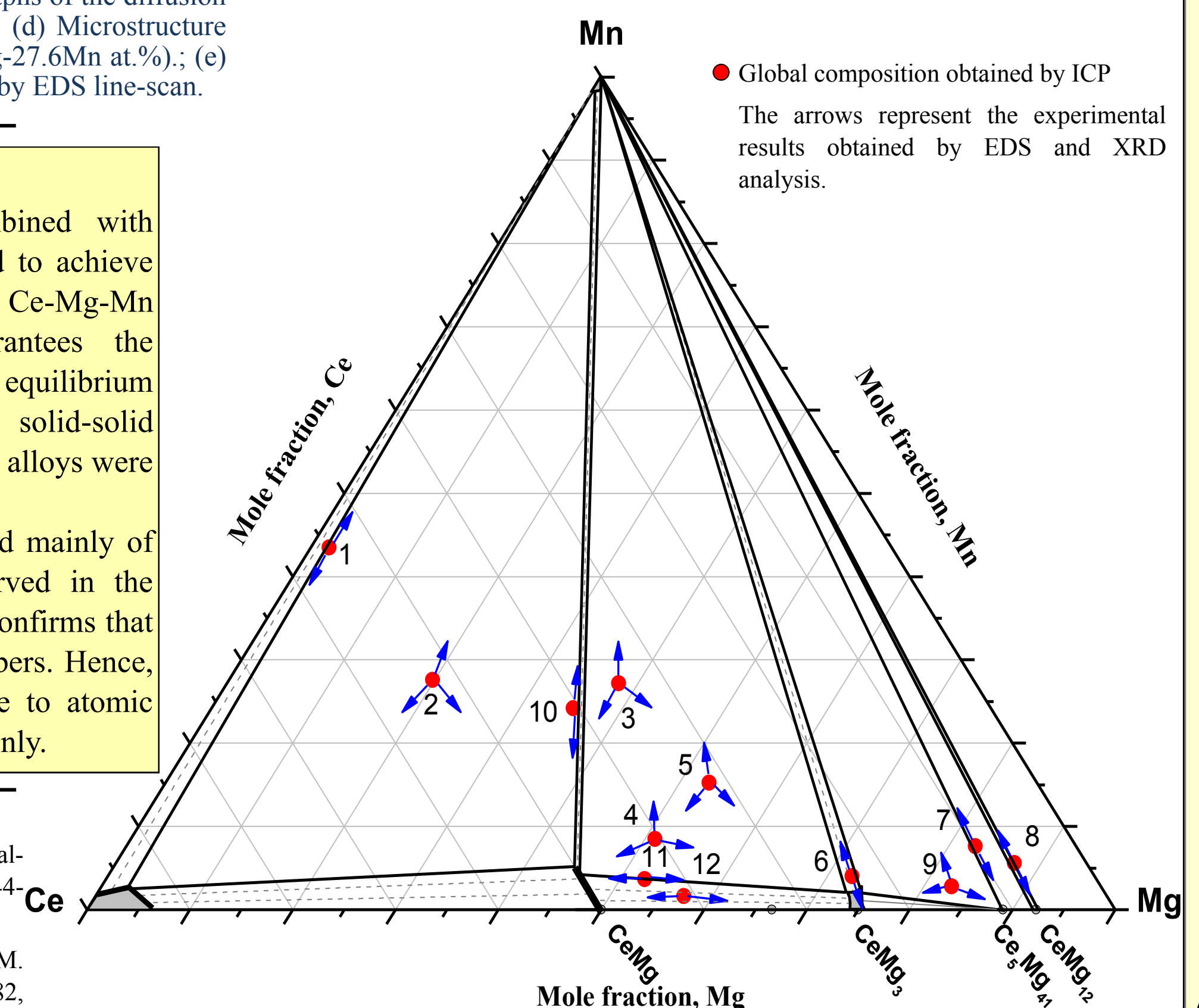


Figure 8: Phase relationships inferred from phase equilibria and diffusion paths analysis

Acknowledgment

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