IOCM 2025 Conference
The 4th International Online Conference on Materials
3–6 November 2025 | Online
MDPI

Influence of Platinum Addition on the Microstructure and Selected Properties of René N5 Nickel-Based Superalloy

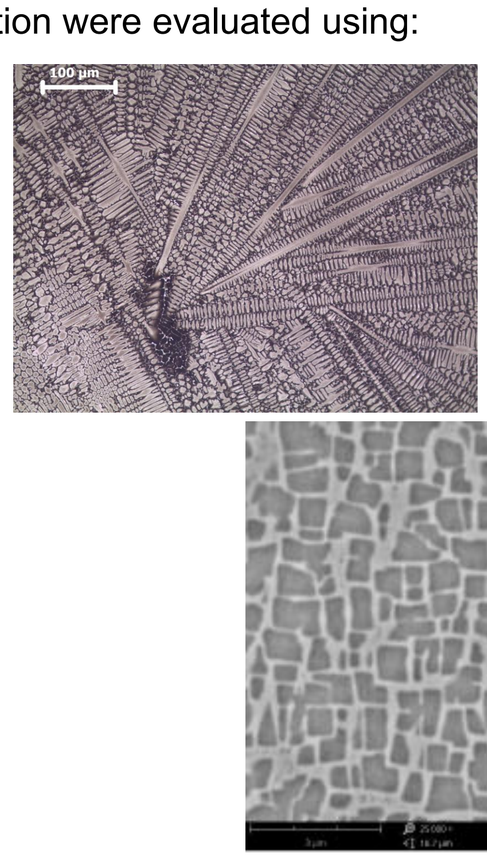
Wojciech Buda[1], Łukasz Rakoczy[1]*
[1]AGH University of Kraków, Faculty of Metals Engineering and Industrial Computer Science, av. Mickiewicza 30, 30-059 Kraków, Poland
* lrakoczy@agh.edu.pl

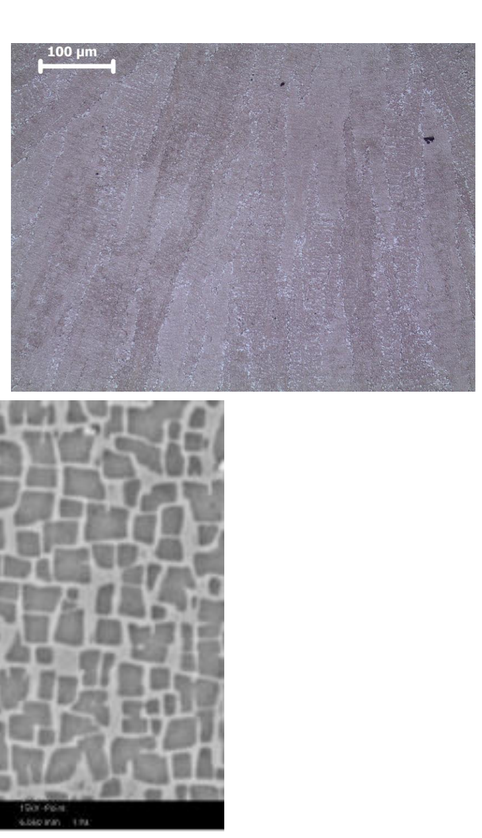
INTRODUCTION & AIM

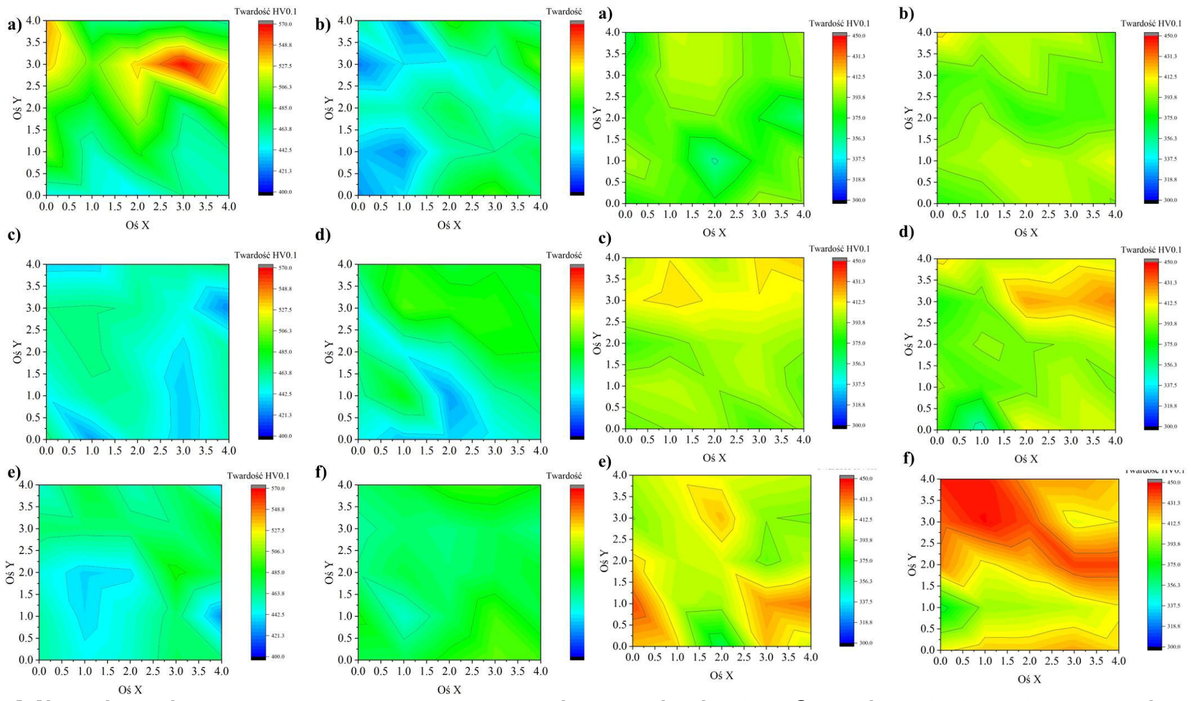
Nickel-based superalloys are key structural materials used in the turbine blades of aircraft engines that operate above 1000 °C. Their superior creep resistance and thermal stability come from the γ matrix reinforced by coherent γ′ precipitates. Platinum is a noble metal with a high melting point and excellent chemical stability. In Ni-based superalloys, Pt can increase oxidation resistance, improve γ/γ′ lattice coherence, and reduce diffusion-controlled degradation at high temperatures. An aim is to investigate the effect of 1-5 wt.% platinum addition on the microstructure and microhardness of René N5 superalloy.

METHOD

The René N5 alloy was modified with 1-5 wt.% platinum and produced by arc-melting followed by suction casting to obtain cylindrical samples. After casting, the material was examined in both the as-cast state and after a multi-step heat treatment consisting of solutioning at 1275 °C and two-stage ageing to promote γ′ precipitation. Microstructure and phase evolution were evaluated using:

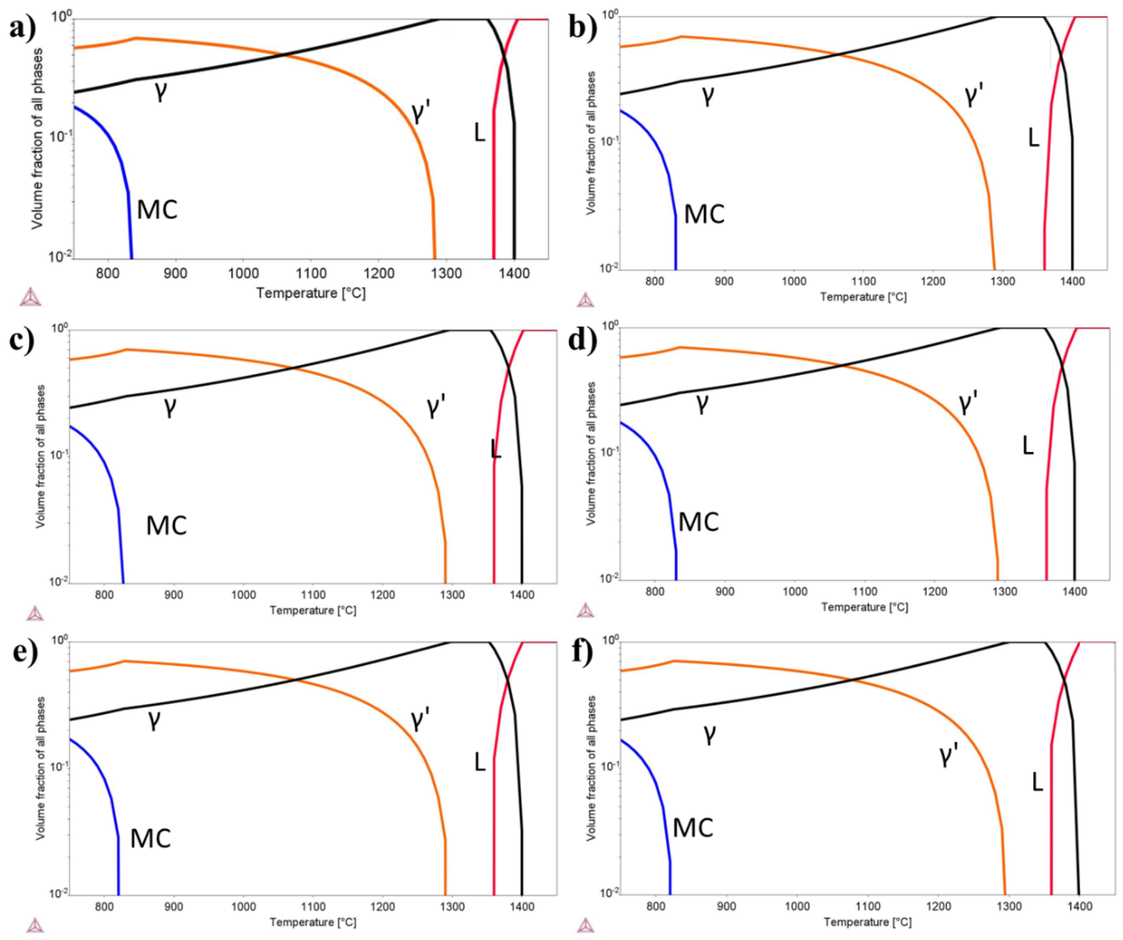






Microhardness measurements showed that after heat treatment the hardness increased with platinum content, rising from ~387 HV0.1 for the Pt-free alloy to ~420 HV0.1 at 5 wt.% Pt (with as-cast values ranging from ~486 HV0.1 without Pt to ~477 HV0.1 at 5 wt.% Pt).

RESULTS & DISCUSSION



Thermodynamic simulations showed that increasing the platinum content in the René N5 alloy leads to a gradual decrease in the liquidus temperature by approximately 15-20 °C in the 0-5 wt.% Pt range, while simultaneously increasing the γ′ solvus temperature and the maximum γ′ volume fraction. Platinum addition slightly decreased the liquidus temperature while increasing the γ′ solvus and γ′ phase fraction, confirming the stabilizing role of Pt. In the heat-treated condition, higher Pt contents resulted in finer, more uniform, and more cuboidal γ′ precipitates, indicating improved microstructural stability. The highest Pt levels (3-5 wt.%) produced the greatest γ′ refinement and precipitate density. Microhardness increased with Pt after heat treatment, reaching the highest value at 5 wt.% Pt, consistent with the observed γ′ strengthening effect.

CONCLUSION

Platinum addition improves γ′ phase stability and promotes a finer, more uniform cuboidal precipitate morphology in the René N5 superalloy, especially at 3-5 wt.% Pt. As a result, the alloy exhibits increased microhardness and enhanced microstructural stability, indicating the beneficial role of Pt in strengthening nickel-based superalloys for high-temperature turbine applications.

ACKNOWLEDGEMENTS

NATIONAL SCIENCE CENTRE POLAND

This work was supported by the National Science Center (Poland) under project "Monocrystalline Ni-based superalloys modified with platinum for the production of critical rotating turbine components of aircraft engines" (2023/51/D/ST11/00945).