STABILITY OF HARDENING PHASES FOR FUTURE NICKEL-BASE SUPERALLOYS

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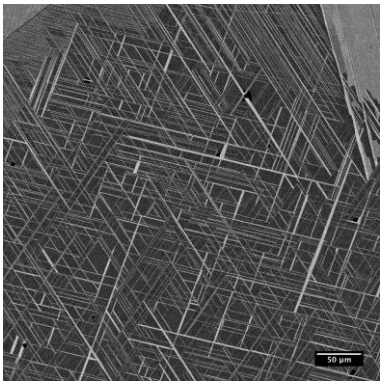

η phase observed in one of the studied alloys

- δ-Ni_3Nb, δ-Ni_3Ta, η-Ni_3Ti and η-Ni_3(Al,Nb) phases are investigated
- Model alloys produced using bibliography analysis and thermodynamic calculations (Thermo-Calc software)
- Influence of chemical composition and temperature on the stability of different phases is discussed

Abstract:

Polycristalline nickel-base superalloys present remarkable mechanical properties at high temperatures thanks to their specific γ-γ' microstructure. However it appears more and more difficult to keep going the race for higher turbine inlet temperature by optimizing the composition and microstructure of γ-γ' nickel base superalloys.

An accurate survey of patents on new compositions of nickel-base superalloys for turbine discs published in the last ten years coupled with a bibliography analysis suggest the intention to replace γ' precipitates by other phases (more stable at temperature higher than 800 °C) to provide precipitation hardening. However, there is still a lack of information about these phases (like η or δ) in terms of crystallographic structure, precipitate morphology, composition and thermodynamic stability. For instance, η and δ phases may often be confused. Nevertheless, the different properties of hardening phases should be well established to be able to ensure an optimal hardening effect through appropriate heat treatment resulting in required precipitate distribution.

Therefore, the present study aims at determining the temperature stability of phases possessing potential hardening effect, like δ-Ni_3Nb, δ-Ni_3Ta, η-Ni_3Ti and η-Ni_3(Al,Nb), for different compositions of nickel-base superalloys intended to be used for turbine disc application.

Nickel-base superalloys of different compositions susceptible to form δ-Ni_3Nb, δ-Ni_3Ta, η-Ni_3Ti and η-Ni_3(Al,Nb) phases are investigated. The key idea is to simplify the chemical composition of existing alloys (available in patents and scientific papers) to avoid the formation of the phases considered as irrelevant in this study, like TCP phases or carbides and borides, which might overburden the microstructures. Such a composition simplification is based on thermodynamic calculations carried out using Thermo-Calc software coupled with TCNI7 database.