Correlation between activation energy and cold rolled on the formation of S' phase in Al_{2024} Alloy

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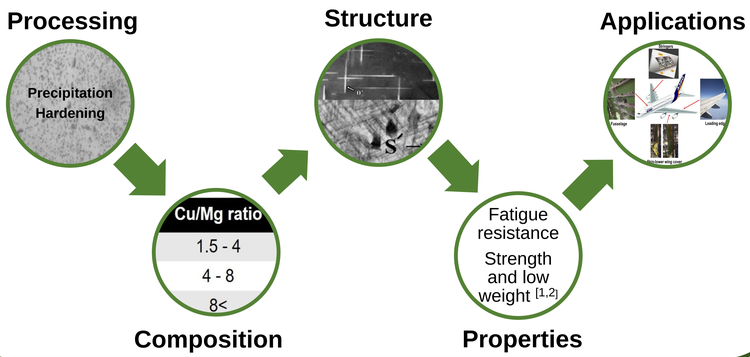
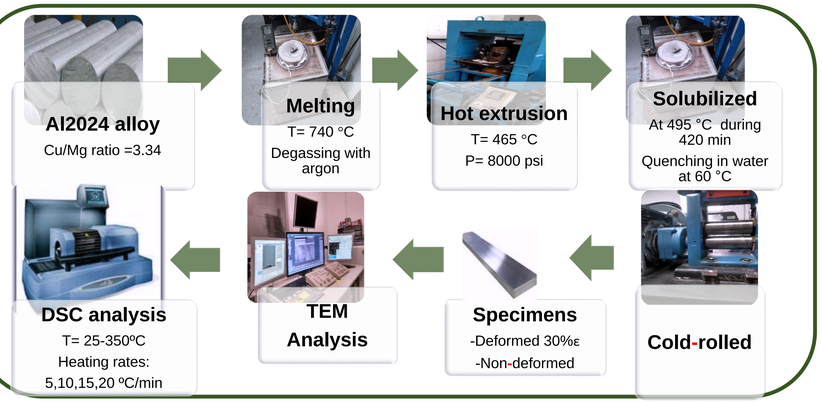
1. INTRODUCTION



2. OBJETIVES

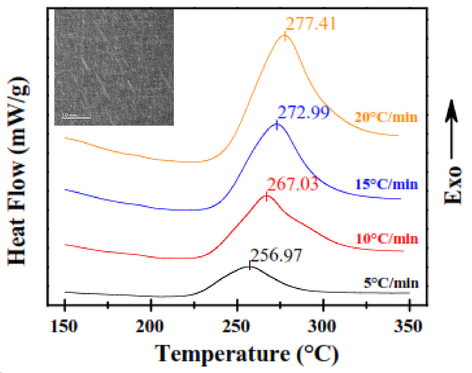
1. To compare Kissinger and Ozawa models to corroborate if to exist significative differences in the activation energy of the S' phase formation using both models.
2. To establish a correlation between the effect of the cold-rolled on the activation energy needed for S' phase formation. Under experimental conditions performed, this will contribute to determining sequence precipitation in the aging hardening process of the 2024 aluminum alloy.
3. To determine the reaction order (Avrami index) to establish the mechanism that controls the S' phase precipitation.

3. METHODOLOGY

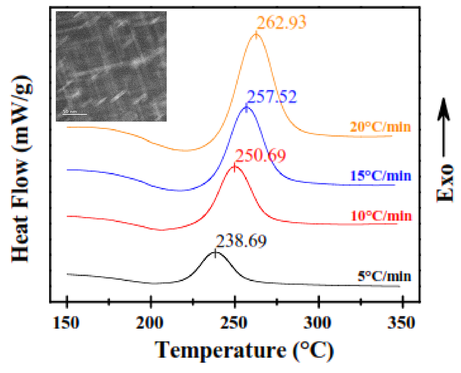


4. RESULTS

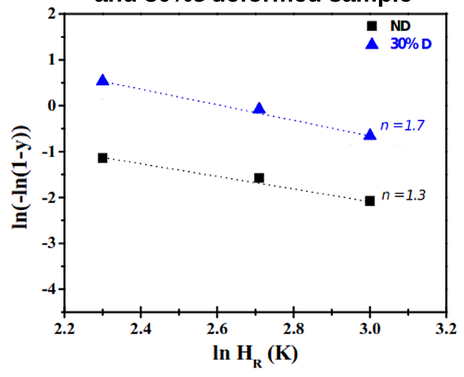
DSC thermogram of non-deformed sample



DSC thermogram of 30%ε deformed sample



Determination of Avrami index for non-deformed and 30%ε deformed sample



Summary chart of activation energy (Q, in kJ/mol) and enthalpy of formation (ΔH, in J/g) for the precipitation of S' phase.

Sample	Kissinger	Ozawa	ΔH ($H_{R=20°C/min}$)	ΔH Average
ND	**142.3** ± 5.8	**151.2** ± 5.8	17.31	17.7
30%D	**124.6** ± 3.4	**133.3** ± 3.4	14.13	14.1

5. CONCLUSIONS

- The activation energy calculated by the Kissinger model is ~5% lower compared to the measurements obtained by Ozawa method. However, following both models, there is a clear trend in which the deformed samples required lower energy for precipitation.
- The deformation grade influences the morphology and size of the S' precipitates, which could have a significant effect on the strengthening of the alloy.
- Avrami index obtained for 30% ε deformed sample (n=1.7) and non-deformed sample (n=1.3) suggest that the phase transformation is controlled by diffusion.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] Wang S.Q., Schneider M., Ye H.Q., Gottstein G., “First-principles study of the formation of Guinier–Preston zones in Al–Cu alloys”, Scripta Materialia, Vol. 51, No. 7, 2004, pp. 665–669.

[2] Li Siyu, Zhang Jin, Yang Jinlong, Deng Yunlai , Zhang Xinming., “Influence of Mg Contents on Aging Precipitation Behavior of Al–3.5Cu–xMg Alloy”, Acta Metall. Sin. (Engl. Lett.), Vol. 27, No. 1, 2014, pp. 07–114.