Interdiffusion and impurity behavior in polycrystalline Mg-Y/Al binary systems

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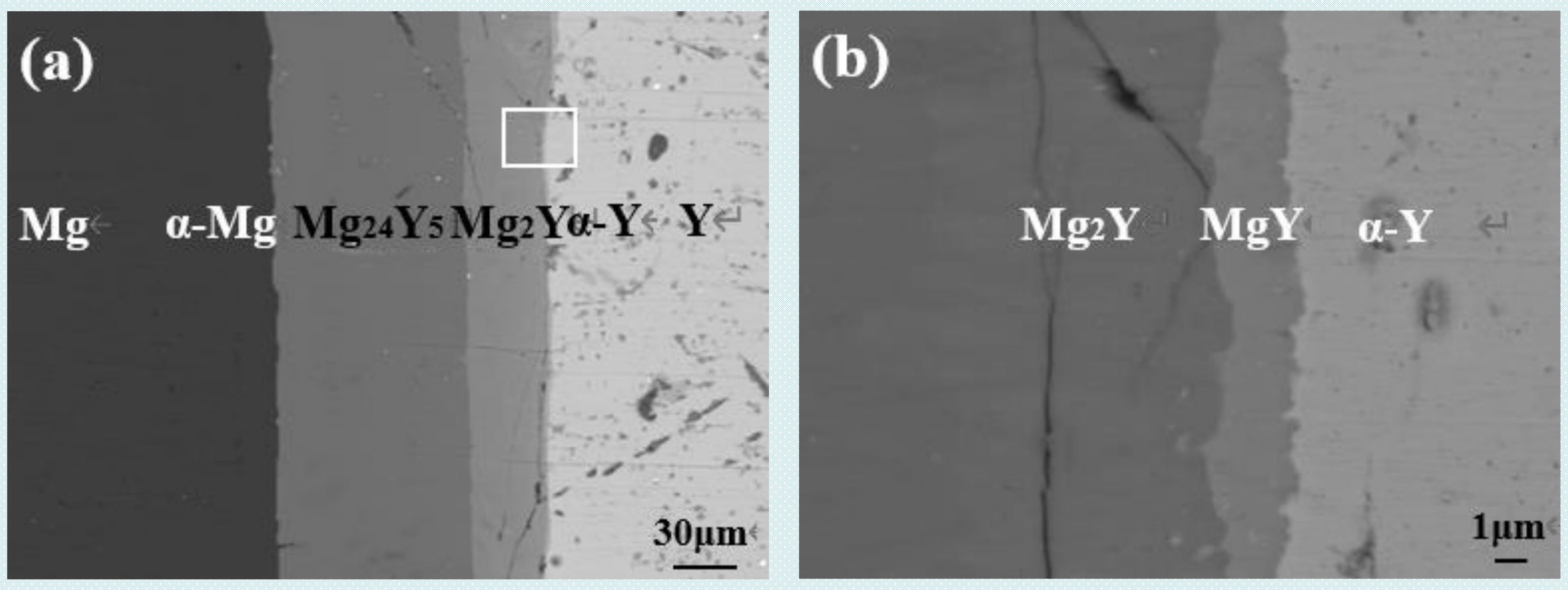
Brief Summary

The diffusion behavior in binary Mg-Y/Al systems was investigated using polycrystalline Mg/Y(Mg/Al) diffusion couples. The interdiffusion coefficients in Mg solid solution and intermetallic phases of Mg-Y system were determined via the Boltzmann-Matano and Heumann-Matano method, respectively. Simultaneously, the Hall method was employed to extrapolate the impurity diffusion coefficients of Mg in pure polycrystalline Y and Y in pure polycrystalline Mg. By the same token, the interdiffusion coefficients in Al solid solution and intermetallic phases of Mg-Al system were also determined.

Results and Discussions



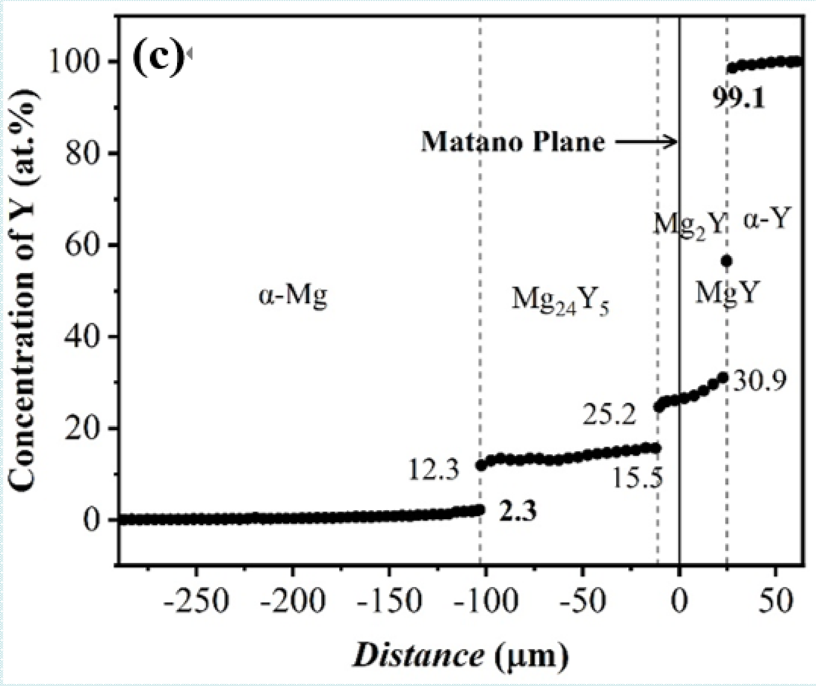


Figure 1. (a) BSE images of the Mg/Y diffusion couple interface annealing at 673 K for 170 h. **(b)** magnified view of Y side at the interface. **(c)** Y solute concentration profile through the diffusion interface. Similarly, the Mg/Y diffusion couples at the other four temperatures (573, 723, 773, 823 K) were determined, too.

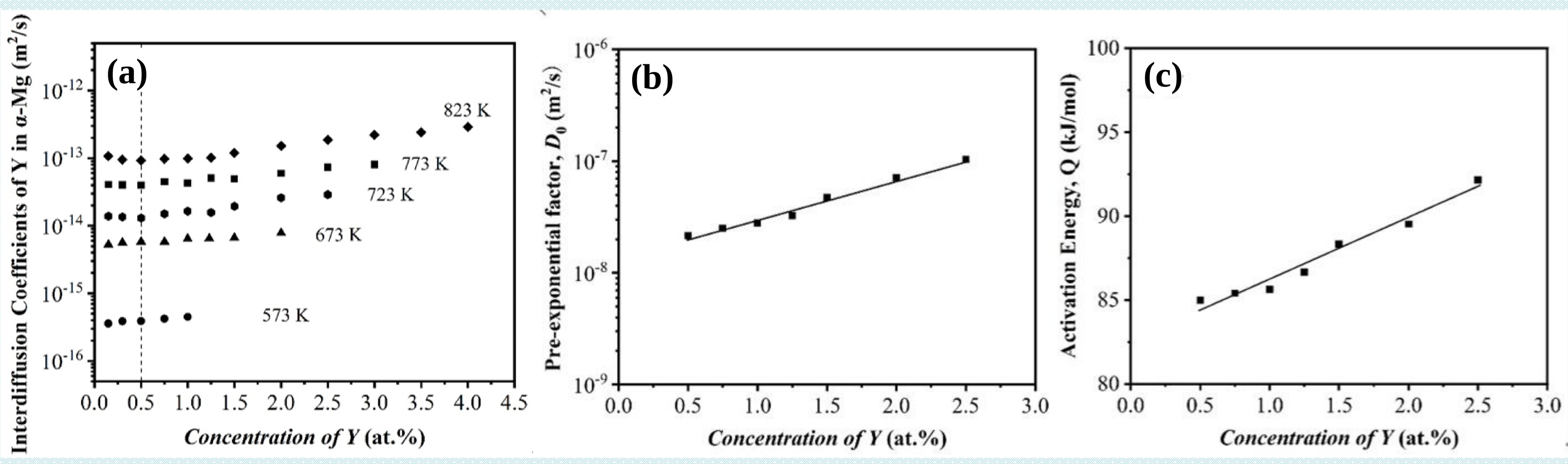


Figure 2. (a) Interdiffusion coefficients as a function of Y composition determined using the Boltzmann-Matano Method at compositions > 0.5 at.% Y and the analytical Hall method at composition < 0.5 at.% Y. **(b)** Variations in pre-exponential factor, **(c)** activation energy as a function of Y concentration in Mg-based solid solution. With an increase in Y concentration, the interdiffusion coefficient in Mg solid solution, the corresponding diffusion activation energy and pre-exponential factor increased.

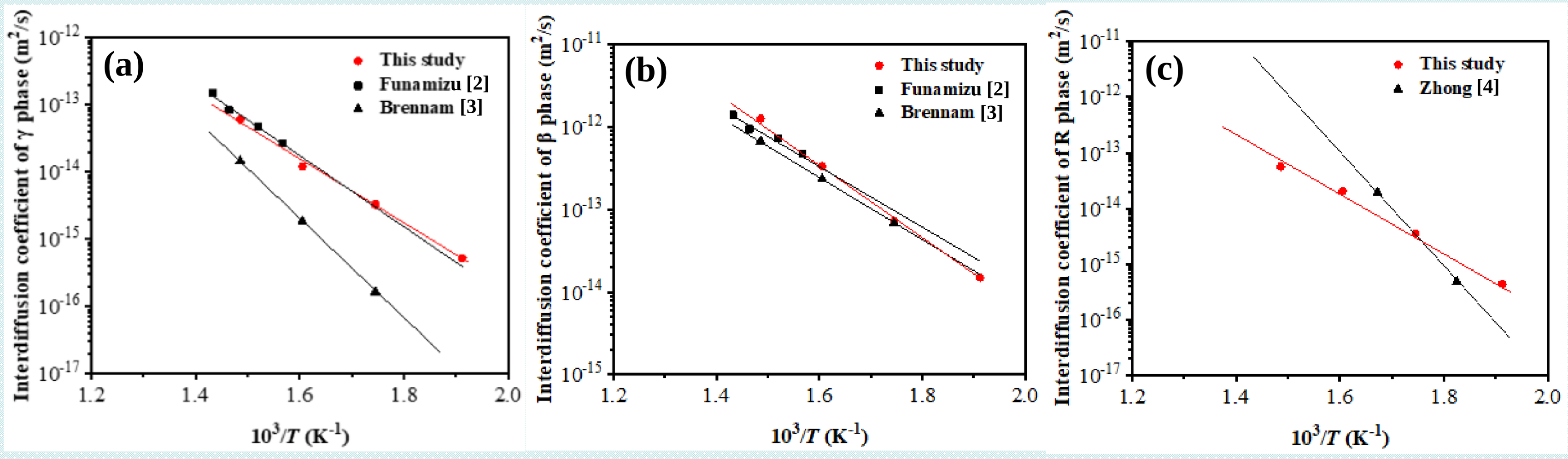


Figure 6. Interdiffusion coefficients of γ, β and R as a function of temperature

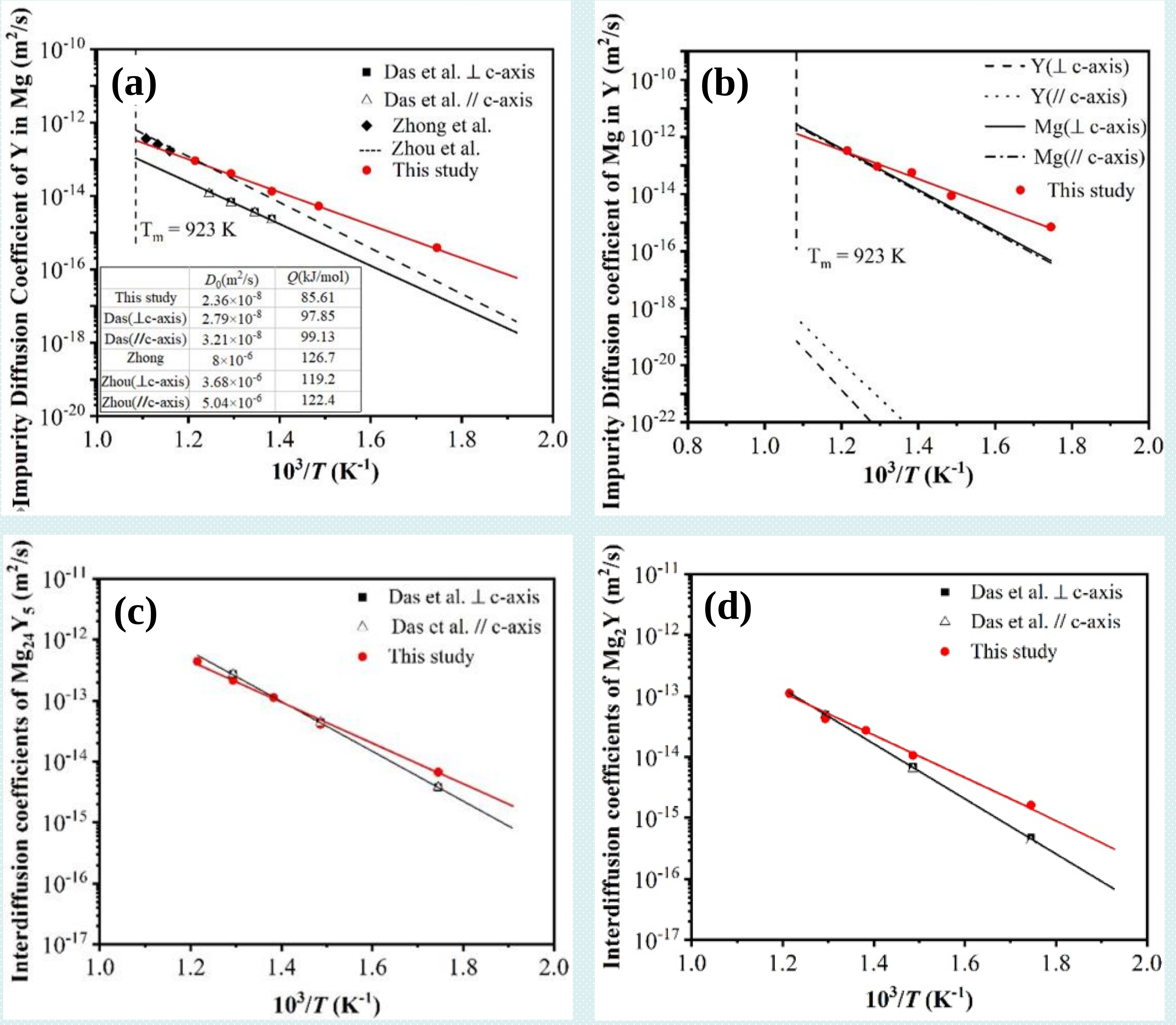


Figure 3. (a) Impurity diffusion coefficient of Y in Mg as a function of temperature. **(b)** Impurity diffusion coefficient of Mg in Y and self-diffusion coefficients of Y, Mg as a function of temperature. Comparisons of interdiffusion coefficients of intermetallic phases in polycrystalline with single crystal Mg: **(c)** $Mg_{24}Y_5$; **(d)** Mg_2Y. For the impurity diffusion coefficients and interdiffusion coefficients, the results obtained by polycrystalline Mg/Y diffusion couples in this study are close to those obtained by first-principles calculations or single crystals at temperatures between 723 and 923 K. Moreover, the diffusion coefficients in polycrystals appear to be higher than those obtained by first-principles calculations or single crystals below 723 K. This indicates that the vacancy diffusion is dominant mechanism above 723 K, while the grain boundary diffusion mechanism dominates below 723 K in polycrystalline Mg-Y binary system [1].

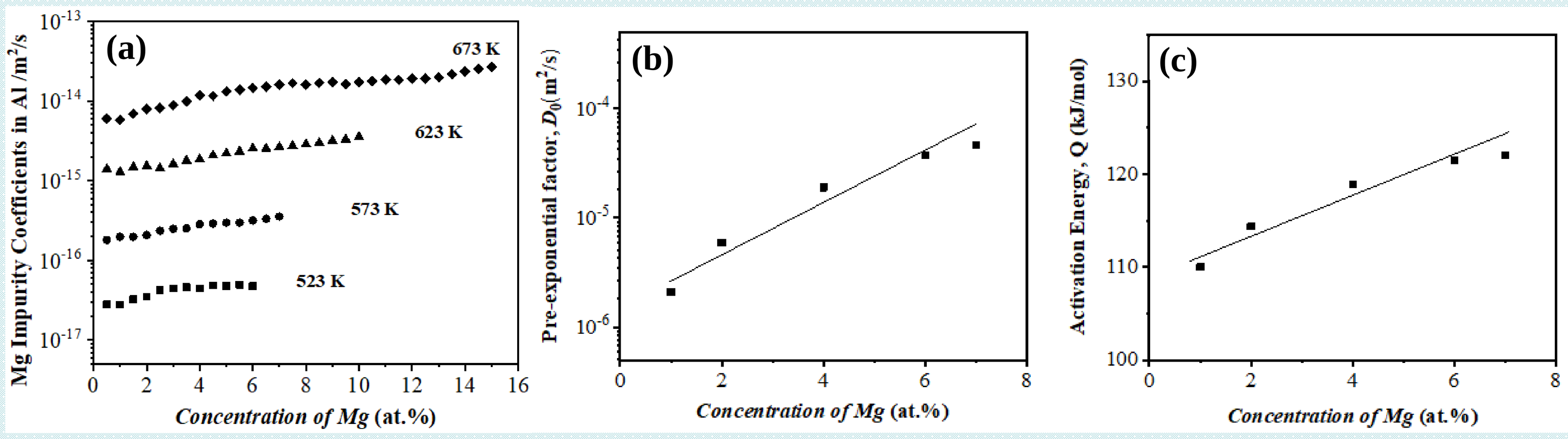


Figure 4. (a) Interdiffusion coefficients as a function of Mg composition determined using the Boltzmann-Matano Method at compositions > 1.0 at.% Mg and the analytical Hall method at composition < 1.0 at.% Mg. **(b)** Variations in pre-exponential factor, **(c)** activation energy as a function of Mg concentration in Al-based solid solution. With an increase in Mg concentration, the interdiffusion coefficient in Al solid solution, the corresponding diffusion activation energy and pre-exponential factor increased.

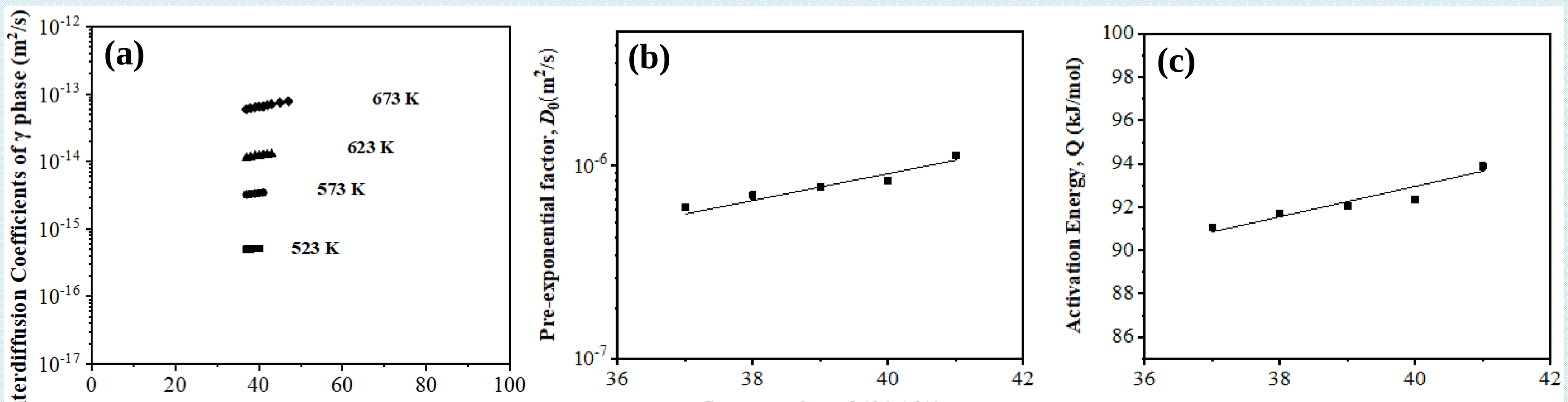


Figure 5. Variation in **(a)** interdiffusion coefficient, **(b)** pre-exponential factor and **(c)** activation energy as a function of Al concentration in the γ phase

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