**Abstract**

Tailoring of microstructure through precise control of thermo-mechanical treatment is essential to obtain the desired properties of 8090 [Al–Li Alloy](https://www.sciencedirect.com/topics/materials-science/aluminum-lithium-alloys) for aerospace applications. Non-destructive diagnosis of nano-scale pre-precipitation and precipitation events, which govern the mechanical behaviour of the alloy, can provide valuable support in controlling the thermal treatment for achieving the peak aged or any alternate desired microstructural state. On-line high temperature evaluation of ultrasonic velocity and attenuation measurements in a series of as-received, solution annealed and prior treated specimens has resulted in differentiating the various phase transitions. The local maximum transition temperatures at the selected heating rate for GP zone formation, precipitation of coherent δ′, dissolution of δ′ and precipitation of stable S′ and δ have been identified to be 368, 470, 532 and 590 K, respectively. It is suggested from this study that the first differential plots of the ultrasonic velocity could be a useful method to differentiate unambiguously all the fine scale precipitation reactions in 8090 Al–Li alloy. [Young's modulus](https://www.sciencedirect.com/topics/materials-science/youngs-modulus) and [shear modulus](https://www.sciencedirect.com/topics/materials-science/elastic-moduli) have been evaluated from the ultrasonic parameters and their effects on temperature and the microstructural state have been studied. SEM and [microhardness](https://www.sciencedirect.com/topics/materials-science/microhardness" \o "Learn more about Microhardness from ScienceDirect's AI-generated Topic Pages) results are found to correlate well with the phase transition behaviour observed by ultrasonic measurements.