Elastic Constants of Platinum Group Alloys (Rh₃Zr and Rh₃Nb) Using Surface Brillouin Scattering

Clemence Sumanya¹,², Bhekumusa A Mathe¹,², Darrell Comins¹,², Arthur G Every², Makoto Osawa³ and Hiroshi Harada³

¹DST/NRF Centre of Excellence in Strong Materials, University of Witwatersrand, Johannesburg, WITS 2050, South Africa
Clemence.Sumanya@students.wits.ac.za, Bhekumusa.Mathe@wits.ac.za, Darrell.Comins@wits.ac.za, Arthur.Every@wits.ac.za,

²Materials Physics Research Institute, School of Physics, University of Witwatersrand, Johannesburg, WITS 2050, South Africa

³National Institute for Materials Science, Tsukuba Science City, Japan
osawamakoto2006@yahoo.co.jp, Harada.Hiroshi@nims.go.jp

Abstract
Platinum metal group alloys are promising materials for use in future ultra high temperature gas turbine engines owing to their excellent high-temperature properties. In the present work the elastic constants of single crystals of Rh₃Nb and Rh₃Zr are investigated by the Brillouin scattering technique that relies upon the inelastic scattering of photons by thermally activated elastic waves. Surface Brillouin scattering (SBS) allows surface acoustic waves (SAWs) to be studied, and hence permits the elastic properties of an opaque material to be determined. SBS spectra for a range of wave vector directions from the (001) surface have been acquired to study the angular variation of the velocities of the observed SAWs and the longitudinal lateral wave within the Lamb shoulder. The frequency shifts of the inelastically scattered light from acoustic phonon modes propagating in [100] and [110] crystalline directions have been measured for long spectral accumulation times and used for a unique extraction of the elastic constants at room temperature. Two approaches have been developed to determine elastic constants using SBS. One approach involves the fitting of the velocity dispersion curves using a χ² minimisation procedure applied to the observed modes, namely the Rayleigh SAW, pseudo-SAW and longitudinal lateral wave (LW). The other is an analytical approach which involves the construction of a merit function from explicit secular functions that determine the surface and lateral wave velocities in the [100] and [110] directions.

Keywords: Surface Brillouin scattering, elastic constants, platinum group alloys