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Characterisation of Crystalline Silicon Fibres produced by IKZ Berlin for the ET-LF payload

With the plans for ET-LF to operate at cryogenic temperatures, there is a need for advanced, low-noise crystalline suspension systems to reach the required sensitivity goals. Crystalline silicon is a promising candidate for suspension elements due to its favourable properties at cryogenic temperatures, including a high quality factor, high thermal conductivity and advantageous thermoelastic properties. It has been shown that these properties, as well as mechanical strength, are dependent on the surface quality and fabrication process of the material. Therefore, an optimised production process for crystalline fibres is crucial, along with thorough investigation of their properties. In this study, we present the characterisation of crystalline silicon fibres grown using the float-zone technique by the Institut für Kristallzüchtung (IKZ) Berlin. We examine material purity levels, crystal orientation, and diameter uniformity, alongside in-depth mechanical tensile strength testing via along-axis linear drive and four-point bending techniques. Additionally, we evaluate the thermal conductivity of the fibres to ensure sufficient heat extraction from test masses. These initial results demonstrate the potential feasibility of producing high-quality silicon fibres and indicate that, with further optimisation and characterisation, they have the potential to achieve the necessary low thermal noise performance, reinforcing silicon's suitability as a candidate material for next-generation gravitational wave detectors.

Primary author: NELA, Ardiana

Co-authors: CUMMING, Alan (University of Glasgow); SPENCER, Andrew; PATTERSON, Charlie (Engineering Department, University of Glasgow); WILSON, Claire (Chemistry Department, University of Glasgow); TRAVASSO, Flavio; HAMMOND, Giles; LACAILLE, Gregoire (University of Glasgow); BUCHOVSKA, Iryna (Leibniz-Institut für Kristallzüchtung); HOUGH, James; HAUGHIAN, Karen (University of Glasgow); TOLAND, Karl; JONES, Russel; DUGMORE, Sarah (Chemistry Department, University of Glasgow); ROWAN, Sheila (University of Glasgow)

Presenter: NELA, Ardiana

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