



# ME Seminar



## Cone cracks in the soft matter during needle insertion

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### ABSTRACT

Needle insertion, a standard process for various minimally invasive surgeries, results in tissue damage which sometimes leads to catastrophic outcomes. Opaqueness and inhomogeneity of the tissues make it difficult to observe the underlying damage mechanisms. In soft biological tissues, the lateral cracks cause more damage to the tissue and increase the pain. In this context, to minimise the tissue damage, it is essential to understand the underlying mechanisms of formation of various cracks, crack nucleation and crack propagation in soft tissue-mimicking materials during deep penetration.

In this talk, we discuss the fracture behaviour of soft, transparent, tissue-mimicking gels during deep penetration of a sharp needle. The insertion force shows multiple events, characterised by a gradual increase in the force followed by a sharp fall. Synchronised recording of the needle displacement into the gel shows that each event corresponds to a stable cone crack propagation. For the first time, we observed nearly periodic, stable, and well-controlled 3-D cone cracks inside the soft gel during deep penetration. We show that the stress field around the needle tip is responsible for the symmetry and periodicity of the cone cracks. These results provide a better understanding of the fracture processes in soft and brittle materials and open a promising perspective in needle designs and the control of tissue damages during surgical operations.

### ABOUT THE SPEAKER

Dr Muthukumar M is a postdoc fellow in the Department of Mechanical Engineering at IISc. He has completed an undergraduate in Aeronautical Engineering from Anna University, Master's in Aerospace Engineering from IIT Kanpur and PhD in Mechanical Engineering at IISc Bangalore in 2017. After that, he completed a one-year postdoc in the Department of Mechanical Engineering at Tokyo University, Japan. During PhD and postdoc, he investigated the influences of microscale, nanoscale, and bioinspired textured surface on macroscopic tribological properties. Recently, he shifted into his long-term research interest in mechanical, and fracture characterisation of bio-mimicking materials. He is primarily an experimentalist, and his research interest involves both fundamental and applied aspects of nano and biocomposite coatings, developing biomedical instruments for medical practitioners. He is one of the founder directors of Marche Healthcare Pvt Ltd; the company primarily focuses on research and development of biomedical tools.



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