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SPACE ELEVATOR TETHER MATERIALS: AN OVERVIEW OF THE CURRENT CANDIDATES

Abstract

This paper reviews manufacturing progress in making materials that have the strength necessary to form the tether for the space elevator. These fall into two categories, nanotubes and 2D materials. The aim is to raise awareness of the properties of these new materials and the state of the art of manufacturing methods. A NASA Innovative Advanced Concepts (NIAC) space elevator feasibility study concluded in 2003 that the "space elevator could be built in the near future with acceptable risk and less funding than some current space programs". The key technology that needed development was the tether component. The study concluded that carbon nanotubes were the material of choice for the tether.

Considerable effort has been invested in manufacturing carbon nanotubes. Publicly disclosed information reveals that the longest carbon nanotube made is 0.5 metre. The current state of the art is to manufacture carbon nanotubes in bundles called forests. Waseda University has shown that these can be grown at lengths of 0.14 metre, at speeds of one metre in 186 hours. One year after the NIAC feasibility study was published, a new class of materials was isolated for the first time. In 2004, graphene was isolated as the world's first two-dimensional material. In 2010 the Nobel prize was awarded to the researchers who isolated and characterised the material, discovering it to have a similar tensile strength to carbon nanotubes (130 GPa).

In the past decade much academic and industrial research effort has resulted in the manufacture of graphene as a large area material that can be manufactured at speeds of two metres per minute and lengths of up to one kilometre. While the manufacture of tether quality material still needs more development, the trajectory to a high-quality industrial product is clear. This paper will detail the current state of the art of manufacturing for these tether candidate materials.