Fracture and adhesion of super-nanomaterials: graphene (the strongest) and spider silk (the toughest)

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In this Plenary Lecture we will present our recent results on the fracture and adhesion of 4 super-nanomaterials:
(i) Graphene, that is the strongest, for which we will briefly discuss the role of defects on the fracture strength (by applying our Quantized Fracture Mechanics [1-3], later called by other Authors also Finite Fracture Mechanics; it represents the energetic counterpart of the stress-based approach proposed by the famous Russian School) and the role of adhesion on Nanoscrolls, as we have investigated in a series of papers in collaboration with H. Gao and coworkers, e.g. [4, 5] (we will also consider collapsed nanotubes as graphene cables [6]).
(ii) Spider silk, that is the toughest, for which we will discuss the mechanics, including the flaw tolerance, and the related implications on the entire web, as we have recently investigated in a series of papers with M. Buehler and coworkers, e.g. [7, 8].
(iii) Gecko foot, that is the most adhesive, for which we will discuss the crucial role of the new Theory of Multiple Peeling [9] for understanding the smart adhesion.
(iv) Lotus leaf, the is the most anti-adhesive, for which we will discuss the crucial role of the hierarchical topology [10] in order to activate fakir drops and thus a super-hydrophobic behavior.
All models are wrong but some are useful (George Box).

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