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Analytical modelling explains paradoxical situations in material behaviour and performance

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Merits, attributes and challenges associated with the application of analytical (mathematical) predictive modelling in electronics and photonics materials science and engineering are addressed, based on the author's research during his tenure with Bell Laboratories, and then – with UC-Santa Cruz, Portland State University, and small business innovative research (SBIR) ERS Co., USA. The emphasis is on some practically important, yet paradoxical, i.e., intuitively non-obvious, materials behaviours. It is concluded that when materials' reliability is imperative, ability to effectively quantify it is a must, and that analytical modelling techniques are the most suitable to explain and quantify material behaviours, especially in extreme, extraordinary and paradoxical situations.