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International Conference on

Applied Physics & Laser, Optics and Photonics

April 15-16, 2019 | Frankfurt, Germany

Some critical problems of the physical design and performance of electronic and optical materials, assemblies and systems: Application of analytical modelling

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Some critical problems of the mechanical behavior and performance of electronic and optical materials, assemblies and systems are addressed and discussed. It is shown that application of analytical modeling (always confirmed by finite-element-analyses) enables to reveal and explain the underlying physics associated with such, often non-obvious, always non-trivial and sometime even paradoxical, problems. Some of the addressed problems are: interfacial thermal stresses in adhesively bonded or soldered assemblies and application of inhomogeneous attachments for lower thermal stresses; thermal and lattice mismatch stresses in semiconductor crystal grown assemblies; dynamic response of electronic systems to shocks and vibrations; stress relief in solder joints owing to their elevated stand-off heights; using inhomogeneous solder joint systems for lower thermal stresses; thermal stress in flexible electronics; incentive for mechanical pre-stressing of accelerated test specimens subjected to thermal loading; stress relief in thermoelectric module designs using thinner and longer legs; low-temperature micro-bending of long-haul dual-coated optical fibers; two-point bending of optical fiber specimens. It is concluded that while all the three basic approaches in microelectronics and photonics materials science and engineering - analytical (mathematical) modeling, numerical modeling (simulation) and experimental investigations - are equally important in understanding the physics of the materials behavior and in designing, on this basis, viable and reliable electronic devices and products, analytical modeling occupies a special place owing to its ability to provide clear and concise information of the problems it addresses.

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