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Advanced Layer-based Sensor Principles: Surface Plasmon Resonance, Air-coupled Ultra Sonics, Magneto-optical Coupling

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Plasma processing is the key technology for surface engineering. The functionalization of surfaces can be accomplished beyond the thermo-dynamic equilibrium at low temperatures on almost all substrate materials. Hence, micro- and sensor-systems in sensor-on-chip technology can be realized with both vertical micro- and nano-designs.
Four layer-based sensor principles and their applications are presented, i.e. surface plasmon resonance enhanced ellipsometry (SPREE) for detection and monitoring of hazardous gases, air-coupled ultrasonic transducers based on either surface-modified cellular polypropylene ones or thermo-acoustic ones with layers on quartz glass, polycarbonate and polypropylene for applications in non-destructive testing (NDT), and magneto-optical sensors consisting of smart-coated fiber Bragg gratings (FBG) for structural health monitoring (SHM).
The interdependence of substrate features, coating properties, and layer design is shown for specific target quantities such as gas sensitivity, selectivity, and responsiveness of SPREE-sensors; efficiency, signal-to-noise ratio, pulse shape and duration, lateral resolution, and broadband features of air-coupled sound transducers; sensitivity and responsiveness to external magnetic fields, displacement of Bragg wavelength, and self-diagnostic capability of FBG sensors with magnetostrictive coatings.
Moreover, for all types of sensors, generic features such as short- and long-term stability, crucial process-related fabrication conditions, and effects of operational and environmental parameters are discussed with respect to the sensor performance. It has been shown that appropriate layer design and adapted selection of layer materials (SnO:Fe-Au; Al/Cr, Ti/Al/ITO; Ni/NiFe) result in improved sensor parameters and may enable new sensor applications.

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