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A real-time method for particle fall-out detection and monitoring using pixelated silicon sensors

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Dust and particulate contamination monitoring is vital for sensitive equipment being launched into space. Sensitive surfaces such as optical subsystems are particularly vulnerable to the effects of contamination which would lead to performance degradation. Great care is required to monitor the cleanliness levels of the environments in which the subsystem resides during all phases of the launch; before, during and after. Early warning of contamination incidents and failure analysis are key objectives of contamination monitoring methods. Current adopted approaches tend to be retrospective in nature and/or require human intervention for analysis of contaminants to be performed.

Presented here is a novel approach to monitoring surface contamination, originally developed under contract for the European Space Agency (ESA) for use as an on-board particulate contamination monitor within a rocket fairing. The method assumes that particle fall-out (PFO) landing on a sensitive surface will be similar to that landing on the surface of a pixelated position sensitive CMOS sensor placed nearby. A high-resolution silicon CMOS sensor collects and measures particle-fall out and dust which falls on its surface. This is a real-time, automatic approach which notifies the user of contamination incidents early on, and also allows characterisation of contaminants to be performed so that future sources may be identified and eliminated, for example based on the physical characteristics of a specific material. An algorithm has been devised which detects the difference in light intensity of nearby LEDs due to occultation of pixels by particulates across the surface of a silicon sensor. Sub-pixel detection of particles to smaller than the five-micron level has been demonstrated using this method, in addition to distinguishing between particles and fibres. We will describe this novel use of a pixelated imaging CMOS sensor together with results and future perspectives.

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