Low Coherence Apparatus for Non-Invasive Real Time System Analysis and Process Control

There are many applications where particle characterization measurements can provide manufacturing practices with improved process control. Such data can lead to higher recovery rates, reduced reagent consumption and better product quality. These benefits result in reduced cost and increased profits, thus creating strong justifications for the use of process control instrumentation. Consequently, there is a need for particle measurement instrumentation that can be used in-situ, or within the manufacturing process, for real-time measurements. In a typical process, such as a polymerization or crystallization reaction, particles or droplets are suspended in a flowing medium, either liquid or gaseous, while chemical or physical changes are taking place. In many cases these changes are very dynamic, and thus the materials cannot be measured when removed from the pipeline or vessel requiring the instrumentation to be non-invasive. Light scattering is one of the most commonly utilized approaches towards particle size determination. Unfortunately, current optical technologies are based on turbidity dynamic light scattering or angular resolved light scattering. These intrinsically invasive methods require substantial sampling and dilution procedures, and therefore are not suitable for online process monitoring.

Technical Details

The present invention uses low-coherence interferometry (LCI) in the regime of multiple scattering to noninvasively characterize processes that involve particles present in fluid substances or in air. The invention also uses the LCI information, known as photon path length distribution (PPLD), to determine the characteristics of a sample by comparing the PPLD to that of other known samples. This information can be further used to control manufacturing process in real time, greatly increase efficiency and product yield. PPLD can also be used to obtain a sample-specific optical property that can be further used to assess various structural information of interest, such as particle size, volume fraction, porosity, phase transitions and composition.

Benefits

• Analyzes liquid, suspended particle, stationary and dynamic systems
• Characterizes particles too dense for conventional optical measurement techniques
• Improves process control resulting in reduced cost and increased profits
• Non-invasive, secure, and effective method for particle characterization in real time

Applications

• Characterization of coal particles, dense sprays and solid propellants

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• Particle sizing of powders within the chemical, pharmaceutical, utilities, petrochemical, cement and food industries
• Spatially distributed control of chemical processes such as emulsion polymerization to produce paints, coatings and synthetic rubbers
• Water quality control

Pollution monitoring

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