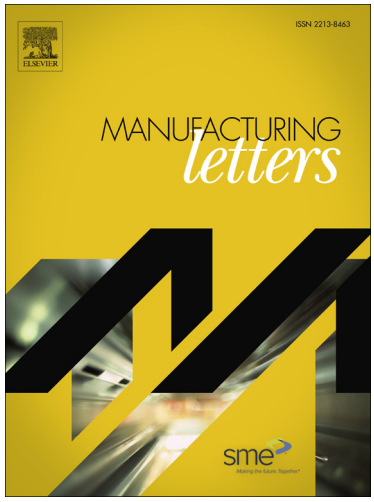

Letters

Methods and Materials for Smart Manufacturing: Additive Manufacturing, Internet of Things, Flexible Sensors and Soft Robotics

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Methods and Materials for Smart Manufacturing: Additive Manufacturing, Internet of Things, Flexible Sensors and Soft Robotics

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Abstract

With the advent of the Fourth Industrial Revolution, the realization of smart manufacturing and Industry 4.0, rapid advancements in technologies will change manufacturing of goods and services apart from how we live. Innovation in digital technologies will have to be accompanied by advances in manufacturing processes and materials, to keep up with the transition. This paper will review and discuss the methods and material technologies present now, along with challenges to overcome, which will be critical for enabling smart manufacturing in the form of the Internet of Things (IoT), cyber-physical systems (CPS), human-robot interaction, augmented and virtual realities.

Keywords: Sensors; smart manufacturing sensors; flexible sensors; robot-human interactions; Additive Manufacturing; Internet of Things

1. Introduction

Today we are at the cusp of the Fourth Industrial Revolution, as noted by Klaus Schwab [1]. The changes are rapid, and around us – supercomputing, ubiquitous computing, interconnected devices, autonomous vehicles and intelligent robots are few to name. Even within us, we are experiencing changes in how we live, with health monitoring, powered prosthetics, augmented assistive technologies, and even interfacing of the brain with computers. While the first Industrial Revolution brought mechanical innovations like the steam engines and railroads, the second Industrial Revolution brought the concept of mass production with introduction of assembly lines, the Third Industrial Revolution brought the computers and the internet, the Fourth Industrial Revolution is yet to unfold fully [1]. We are at the doorstep of the fourth Industrial Revolution today, combining the forces of digital advancements like wireless networks, computing, cloud infrastructures along with big data and artificial intelligence on one hand; and physical advancements in smart materials, nanotechnology, and 3D printing on the other hand. Access to internet and the explosion of user-generated data has made the possibilities endless, beyond the realm of anything the human mind can imagine. However, researchers in academia and in the industry have recognized that the advent of the fourth Industrial Revolution will transform how products are manufactured, how business is done, how healthcare is administered, and even how we will live. The implications of such technological advancements, within a very short period of time, are still being debated. Necessary skills and re-training workers are being discussed, with concerns for the increase in automation and the future of jobs. Smart factories will incorporate the concepts of Industry 4.0 and smart manufacturing along with embedded sensors, automation, monitoring of products and processes, and robotic augmentations. With the advent of computerization of manufacturing, and supported by technologies such as the internet of things