# HUM-IND4.0: Human-Centred Industrial Technologies

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*Abstract*— **Digitalisation of industry is a growing theme and the human factor is one of its important elements. Internet and local network connect machines, devices and human together to improve device quality and productivity. In this track, it is intended firstly to focus on additive manufacturing technologies which coupled with digitalisation have a strong impact on human interaction, namely, through design freedom and personalisation. Secondly, nano- and micro-technologies have been recognized as key enabling technologies by the European Commission and promise great outcome in medical and other sort of human-centred applications. Six papers address the spectrum of human centred industrial technologies and describe new applications and approaches.**

***Keywords-additive manufacturing; industry 4.0; nanotechnologies; safe-by-design; flexible multilayer printed systems; medical application.***

## I. INTRODUCTION

The industry is changing fast, so fast that specialist call it an industrial revolution. They are different drivers of those changes and they will be discussed later, but the main one is the digitalisation of the industry. Therefore, Industry 4.0 is also called the industrial internet of things or smart factories [1-4].

The connection of workers and machines to the internet enables a bunch of new application driving to an increase in productivity and a change in the way of working. Nevertheless, not only the working habits are changed but also the way to produce. Indeed, the digitalisation of object and the emergence of additive manufacturing- characterized by almost endless design freedom- bring new market opportunities but also new challenges. Customized and small batch products can be produced using 3D printing but a limited amount of material are yet available.

In the additive manufacturing domain, different technologies already exit. The Inkjet technology is one of the technology discussed in this track. New researches on nano-particles based inks are conducted in order to improve material properties -such as conductivity- and stress resistance. As it is often the case when nanotechnology are involved, safety concerns arise. It is why a safe-by-design approach will be presented.

Additive manufacturing technologies based on flexible multilayer printed systems are also discussed in this track as well as their challenges.

To finish, the concept of medical application using nanotechnologies is described.

## II. SUBMISSIONS

The first paper is entitled “Industry 4.0 and the Futur Revolution for Human-Centred Industry” [5]. The authors notice that the development of new technologies namely in the microelectronic and the communication domains drives a new industrial revolution. As every revolution, industry 4.0 will change our way of working and bring new opportunities and challenges. This paper presents the new technologies and human-centred applications related to industry 4.0 and concludes on what it will bring to humans and societies.

The second paper is entitled “Industry 4.0 Human-Oriented Challenges using the example of Additive Manufacturing Technologies” [6]. Digitalization of the industry opens new possibilities to fulfill customer requirements such as individualized products. Additive Manufacturing is an example of a technology to do so and is part of a development towards Systems Engineering. Adapting the qualification of the workforce is a decisive factor to use successfully new technologies within the broad field of industry 4.0. This paper addresses the issue of how to integrate workforce in the changing process of digitalization and provides examples based on the Additive Manufacturing technology. It shows that work content will change and generally higher skill levels are required. Subsequently continuous learning and the will to do so are necessary. Implementing this is a major task for workforce and employer.

The third paper is entitled “Analysis of the cross section of inkjet-printed conductive tracks on PET films” [7]. The

authors present a method to analyze the nano- and microstructure of inkjet-printed conductive tracks on polymer film substrates based on SEM analysis of cross sections prepared by ultramicrotomy. The development of internet of things (IoT) devices, smart sensor systems or wearables necessitates new fabrication technologies. The challenge is to fulfil requirements such as flexibility, low-weight and low-cost. Inkjet printing of conductive microstructures on polymer films has become increasingly important for these applications in the last decade. This additive fabrication approach is potentially more ecofriendly than conventional processes but has still not reached wider implementation in industry. One of the potential reasons is the still insufficient reliability of printed components that must sustain electrical, thermal, mechanical and chemical stress. In order to optimize the fabrication process with regard to these requirements, the nano- and microstructure of printed structures needs to be analyzed. In the paper, a method is outlined for the nano- and microstructure analysis of inkjet-printed conductive tracks on polymer substrates by means of SEM analysis of cross sections prepared by ultramicrotomy.

The fourth paper is entitled "Nano inks for additive manufacturing – a safe-by-design-approach"[8]. Additive manufacturing enables a new manufacturing paradigm, such as the rapid, distributive manufacture of complex 3D objects. Nanoparticles are in particular suitable for ink formulation of novel PolyJet inks to obtain functionalities embedded in the additive manufacturing process. However, the impact and interaction of nanomaterials on environment and human health is widely discussed today. The paper deals with a safe-by-design-approach that is developed in this context.

The fifth paper is entitled "Bonding of flexible multilayer printed systems based on PET-substrates – An investigation of challenges and promising approaches"[9]. During the production process for flexible multilayer printed systems the bonding of the individual substrate layers is an important step. Thereby, the functionality of the components and lines printed onto the different layers must not be affected. In the paper the challenges of the bonding process of flexible printed systems based on PET-substrates are demonstrated and possible approaches for bonding are introduced and compared to each other.

The sixth paper is entitled "Concept of an Active Optical Subsystem for Use in an Ophthalmic Implant" [10].This paper describes the concept of an active optical subsystem for use in a demonstration model of an ophthalmic implant. The active optical subsystem consists of the three principal components optics, actuator, and amplification linkage. The main focus of the work presented is on the robust concept and mode of operation of the active optical subsystem.

## III. CONCLUSION

The HUM-IND4.0 special track covers a wide spectrum of topics related to Industry 4.0, additive manufacturing and human centered application. It presents academic research papers as well as studies from industry introducing interesting ideas for future work.


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