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Lab-on-a-chip for analysis of blood 12

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12.1 Introduction to microfluidics science

The booming and rapid development of the microelectronic technologies in the 1960s started a new life-changing era to humankind with new living standards. This rapid development introduced unique opportunities to explore endless scientific corners that had not been investigated before and to revisit existing works to enrich the fundamental knowledge and phenomena behind them. This remarkable development in microelectronics technologies was associated with other important developments in microfabrication methods that facilitated the fabrication and testing of new micro-scaled systems (Bragheri et al., 2016). Still, the development of nonelectronic microsystems was not as fast and as huge as electronic systems until the 1970s, where polymer and silicon microfabrication were first introduced (Rapp, 2017). This important and game-changing development provided an excellent opportunity to start a completely new scientific path to investigate closely known physical phenomenon that were not being "observed" or controlled before with the conventional testing methods (Chen et al., 2019; Su et al., 2015; Tay et al., 2016). By then, the "microfluidics" terminology started to be the major definition of a new era in microflow systems and microfabrication methods (MEMS) (Kumar et al., 2019). Microfluidics is a multidisciplinary technology that combines many fields, such as chemistry, biology, biotechnology, and medicine (Bhattacharya et al., 2018; Sackmann et al., 2014; Whitesides, 2006). Microfluidics technology focuses on the design, manufacture, and experimentation of miniaturized fluid flow systems, which have endured tremendous growth over the last 20 years (Abdulbari & Basheer, 2017a, 2017b; Kratz et al., 2020; Leal et al., 2020; Xuan, 2019). Being a multidisciplinary area, this progressively increasing sector of research has a wide variety of uses in biomedical diagnostics (Dimov et al., 2008; Fachin et al., 2017; Karabacak et al., 2014), chemical analysis (Livak-Dahl et al., 2011), automobile, and electronics industries (Ricco, 2006).

Microfluidic mixing and separation techniques are one of the state-of-art technologies that are rapidly evolving and are considered as the heart of any microfluidic chip (Günther & Jensen, 2006). Extensive experiments have shown outstanding mixing effectiveness through simple geometries of microfluidic chips and devices (Gobby et al., 2001; Lee et al., 2011; Paik et al., 2003; Panić et al., 2004). Of the fluids that flow in microchannels, molecular diffusion processes regulate the mixing among deformed fluid elements. Increasing contact area between two species is

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