Damage to Biological Materials During Ink-Jet Printing

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Abstract

Ink-jet printing has excited much interest in recent years as a mechanism for depositing biological materials such as enzymes, growth factors, DNA arrays and living cells. These materials are considerably more complex than traditional materials used in ink-jet systems. They have much higher molecular weights than conventional inks or are living organisms and must retain biological functionality after printing. A number of research groups have already reported their findings in this area and there are some conflicting results e.g. whether protein enzymatic activity is reduced by ink-jet printing and whether cells retain identical viability after printing. Part of this uncertainty has come about because many prior studies have not published sufficient data to allow a thorough statistical analysis.

In this study we present results from systematic studies of damage to mammalian cells after piezoelectric ink-jet printing comparing data from sarcoma derived human fibroblast 1080, primary human osteoblasts and primary bovine chondrocytes. Experimental data has been used in a full statistical analysis to determine the cell survival rates post-printing and the viability of surviving cells, compared to control populations that have not been printed. In all cases cell death rates post-printing are very low but cell death is seen to increase with increasing voltage applied to the piezoelectric actuator. However, the viability of cells that survive the printing process are unaffected by printing conditions.

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Brian Derby is Professor of Materials Science in the School of Materials, University of Manchester, UK. He has research interests in the areas of: 3D printing, drop/substrate interactions during ink-jet printing, direct write electronics and tissue scaffold fabrication.