PREFACE

The current advancement in computer-aided design/computer-aided manufacturing (CAD/CAM) offers a leap ahead in the field of Prosthetic Dentistry. Recent developments in digital intraoral and tabletop scanners have improved the accuracy and precision of data acquisition. Accurate data is a prerequisite during the digital manufacturing.1,2

Unlike conventional, digital subtraction fabrication techniques where the object is milled from solid blocks, additive manufacturing (AM) commonly known as 3D-printing is the process where an object is built layer by layer based on CAD data.3 Size of the tooling and the complexity of the object design are no longer an issue in additive manufacturing.4 Among other advantages of various 3D-printing techniques, material waste can be reduced by 40% and 95-98% of the materials can be recycled.5

Although AM has existed for decades, it is only recently that it attracted the attention of healthcare professionals and researchers from various dental disciplines namely in the field of Prosthodontics.3 AM applications in Prosthodontics range from the fabrication of occlusal devices, dental models, fixed and removable dental prostheses to wax-patterns for future casting procedures3,6-10

The most commonly used AM techniques in Prosthodontics are; stereolithography (SLA), digital light processing (DLP), selective laser sintering/melting/direct metal laser sintering (SLS/SLM/DMLS), and direct deposition modeling/jetting.3

Similar to milling, the design process starts with digital data acquisition followed by data exporting to the design software.11 The manufacturing process, however, is different when using 3D-printing technology. The process starts with a preparatory phase in which the exported data is virtually sliced.11,12 Furthermore, in this stage build orientation/direction, slice thickness and support structure are defined. These parameters are commonly interrelated.12,13 The build direction/orientation can influence the numbers of layers, the amount and distribution of the support structure which affects the surface quality, mechanical properties of the printed object as well as total build time and cost of the manufacturing process.12,14-16 The fabrication process is shown in Figure 1.
At the offset of this project, the application of 3D-printing in the field of Prosthetic Dentistry was limited. Further, prostodontists, technicians and researchers were all clueless regarding the influence of the above-mentioned factors on the overall quality of printed parts and this was what ignited the idea of current thesis at hand.

**Aim and outline of thesis**

The aim is to investigate the application of additive manufacturing / 3D-printing techniques in the field of Prosthetic Dentistry. Further, to investigate the influence of different technical factors involved in the fabrication process on the dimensional accuracy and mechanical properties of the printed restorations and materials. Last but not least, a general discussion is presented on the overall findings and recommendations are formulated that can assist prostodontists when applying this novel technology and areas of future research in this field are highlighted.

To achieve our aim, the following research questions were addressed:

1. How far is the application of additive manufacturing technology in the field of Prosthodontics (chapter 1)?

2. Does the build direction influence the mechanical properties of the 3D-printed restorative material (chapter 2 and 3)?

3. Does the build direction influence the dimensional accuracy of 3D-printed full coverage restorations fabricated using stereolithography and digital light processing technologies (chapter 4 and 5)?

4. What is the influence of different finish line designs on the internal and marginal fit of
3D-printed interim restorations fabricated using stereolithography (SLA) technology (chapter 6)?

5. What is the influence of different fabrication methods (milled vs. printed) on the internal and marginal fit of printed interim restorations (chapter 6)?

6. Where are we concerning the printing of zirconia for dental applications (chapter 7)?