

Commercial filament testing for use in 3D printed phantoms

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Introduction

With the popularization of 3D printing, many areas of knowledge are using this technology to create products and diminish costs, even in health segment. Commercial phantoms are expensive and hard to obtain in development countries. As alternative, 3D printed phantoms can be the way to produce inexpensive and reliable simulators aimed for dosimetry and teaching. That said, the objective of this study is to determine which of the available commercial filaments can be used in 3D printing to mimic human tissue for use in 3D printed phantoms.

Methods

Fourteen 3D printing filaments (ABS, ABS premium, PLA, PLA+Bone, PLA+aluminum, PLA+brass, PLA+cooper, SILK, HIPS, PETG, PVA, Wood, TPU and TPE) commercially available in Brazil had their attenuation tested, using computed tomography. Each material was printed as 2 centimeters edge cube with rectilinear pattern and 60, 80 and 100 percent infill. The cubes were scanned in a Philips CT Brilliance 6 with 120 kV, 200 mA, 2mm slices and standard reconstruction. At the center of each cube, an $\sim 120 \text{ mm}^2$ region of interest were set to measure the mean Hounsfield Unit (HU) and the standard deviation value. For each material a graphic was plotted and the curve equation determined.

Results

The HU of the tested materials ranged from $-516,2 \pm 7,3$ to $329,8 \pm 18,9$. All human tissues could be mimetized with these materials, except bone (mainly cortical bone). Considering the curve equation, the most promising filament was PLA+Cooper, due to the multiple infill configuration that allows the resulting HU range to represent from adipose and skin tissue to marrow bone. With a two extruder printer may be possible add lung tissue to the model and make a 3D phantom more complex and accurate.

Conclusions

With these tested materials, is possible to construct various phantoms, simulating a wide range of tissues. However, any simulator with cortical bone is impaired because none filament achieve the required HU value (at least over 800 HU).