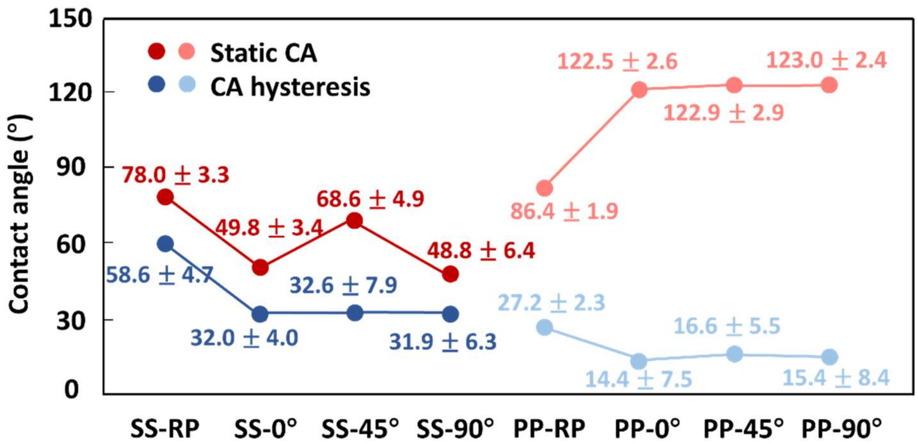
How contact angle measurements can help to develop new materials for 3D printing.

3D printing technology has entered into many fields amongst others in bioengineering, heat exchanger design, thermal process engineering, etc. For thermal separation technology computational fluid dynamic (CFD) simulations are often used to characterize parameters like the liquid holdup, the effective interfacial area, and the liquid distribution. These parameters are often influenced by the wettability of the used material. The wettability is a surface property of the material which can be altered in a 3D printing process. Thus, a systematic study on surface properties of 3D printing materials was recently conducted by Grützner and coworkers focusing on investigating systematically the wettability and surface morphology of 3D printing materials.

As model materials they used polypropylene (PP) and stainless steel (SS) surfaces using selective laser sintering (SLS) and selective laser melting (SLM) technologies to fabricate PP and SS 3D printing materials, respectively. They tested 8 samples of different materials, manufacturing methods and sample orientations listed in **Table 1**. Since the contact angle (CA) is especially important for CFD simulations, CA measurements to determine advancing CAs, static CAs, and receding CAs and the CA hysteresis of all 8 samples were conducted with an optical contour analysis system (**Scheme 1**).

Table 1: Tested samples

Sample denotation	Material	Manufacturing method	Sample orientation
PP-RP	polypropylene	Random packing	/
PP-0°	polypropylene	3D printing	0°
PP-45°	polypropylene	3D printing	45°
PP-90°	polypropylene	3D printing	90°
SS-RP	stainless steel	Random packing	/
SS-0°	stainless steel	3D printing	0°
SS-45°	stainless steel	3D printing	45°
SS-90°	stainless steel	3D printing	90°



Scheme 1: *The static contact angles and the contact angle hysteresis of different samples*

The contact angles vary greatly depending on the sample material, manufacturing method and sample orientation. For the stainless steel samples the static CAs on SS-RP were higher than these on SS-0°, SS-45°, and SS-90°, which means SS-3D printing materials were more hydrophilic; For the polypropylene samples the situation was reversed and the static CA on PP-RP was much lower than on PP-0°, PP-45°, and PP-90°, which means PP-3D printing materials are more hydrophobic. In addition, the randomly packed materials (SS-RP, PP-RP) had a larger CA hysteresis than their 3D printed counterparts. The reason for the changed hysteresis values is a hindered mobility of the liquid mobility in both directions caused by the superordinate structure from the 3D printing process. The sample orientation significantly affected the static CAs for the stainless-steel samples (static CAs of SS-0° and SS-90° are almost the same while that of SS-45° is much higher). The roughness and the waviness of materials play a major role on the measured CAs. The measured CAs for SS and PP correspond very well with the respective values for the roughness—when the roughness was higher, the static CAs were lower; vice versa.

Overall, a systematic study on the surface morphology and wettability behavior of 3D printed materials for thermal separation technology was conducted which can provide more detailed surface parameters when using computational fluid dynamic simulations. This new understanding of the relationship between roughness, waviness, and CAs of 3D printing materials can help to design better thermal separation systems.

An optical contour analysis system OCA 15EC (DataPhysics Instruments GmbH, Germany) was used in this research.

For more information, please refer to the following article:

Investigation of Contact Angles and Surface Morphology of 3D-Printed Materials; Johannes Neukäufer, Bernhard Seyfang, Thomas Grützner; *Ind. Eng. Chem. Res.* **2020***,* 59, 14, 6761–6766; DOI: 10.1021/acs.iecr.0c00430