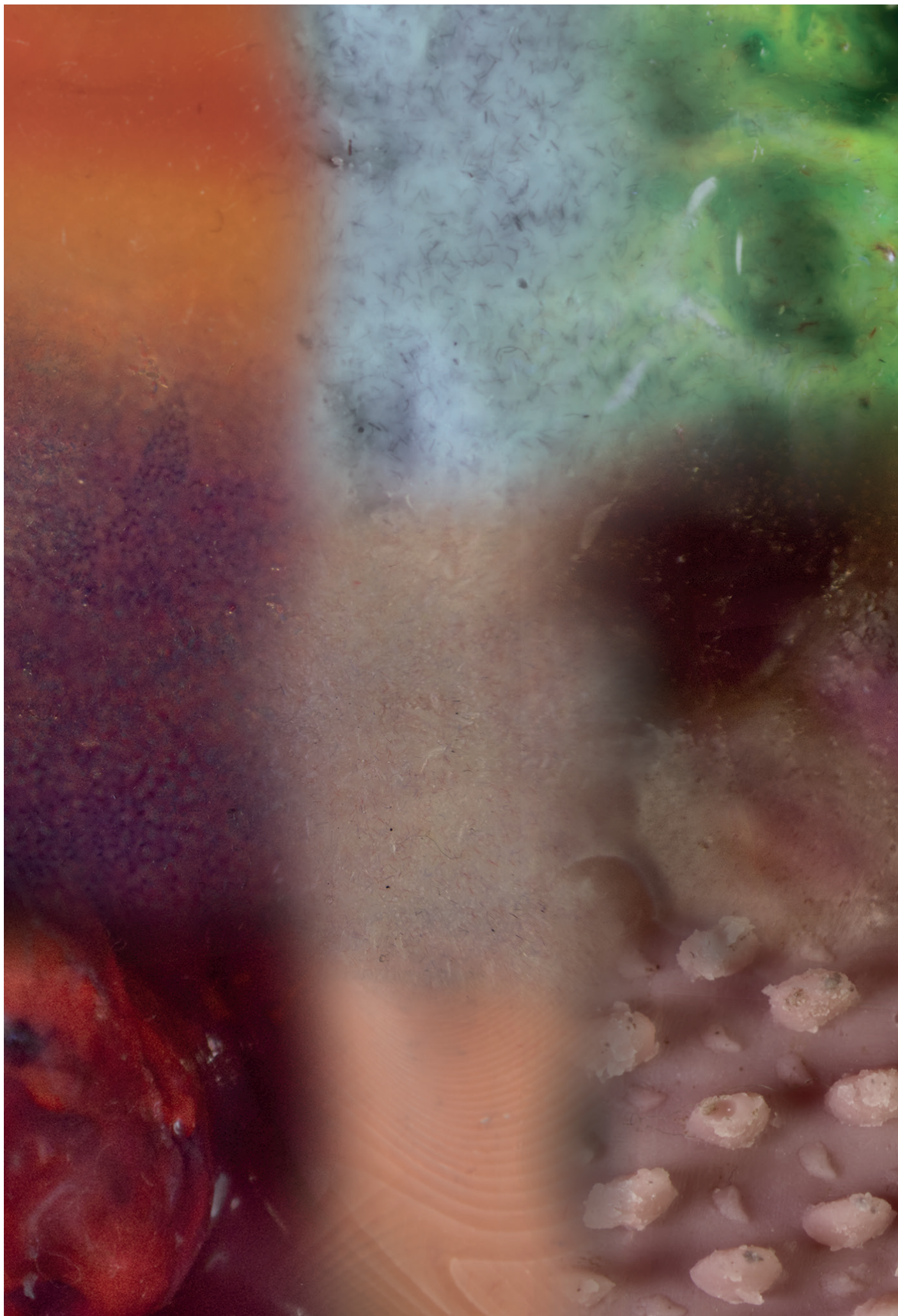




ex silico

soft biomorphs

Mads Bering Christiansen, Ahmad Rafsanjani, and Jonas Jørgensen – July 22, 2024

• soft robotics • bio-inspired • exploration • practice-based research • research through design • aesthetics

Human existence is deeply enmeshed with the natural environment, and humans possess an innate connection with living beings and natural elements. Within art, design, and architecture, this is reflected in the transhistorical concept of *biomorphism*, which refers to a preference for or an interest in organic, lifelike forms that are evocative of nature and natural organisms.

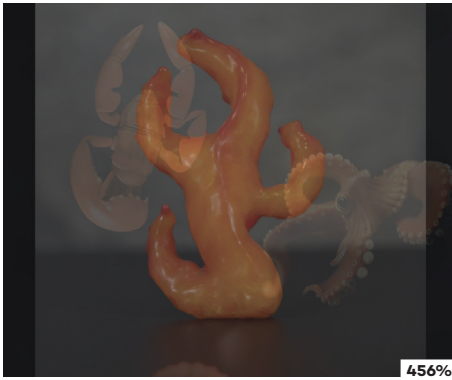
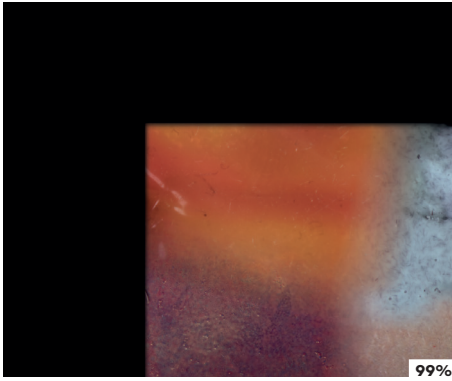
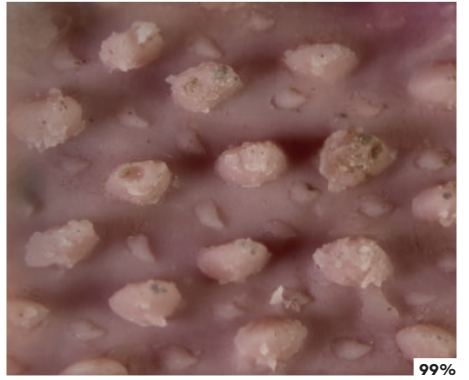
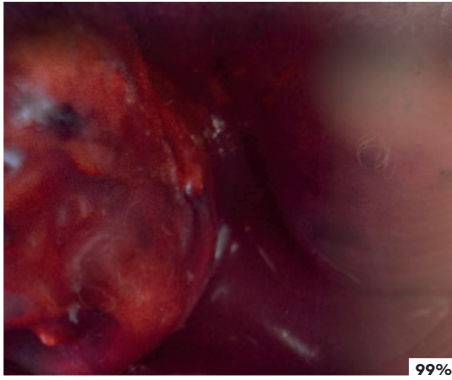
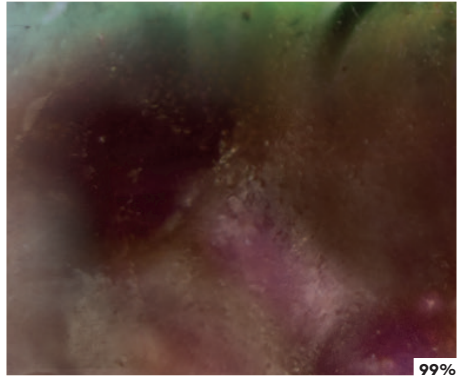
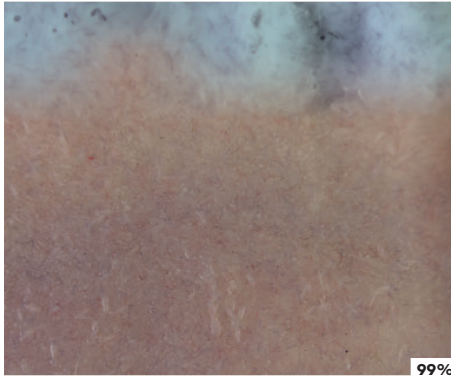
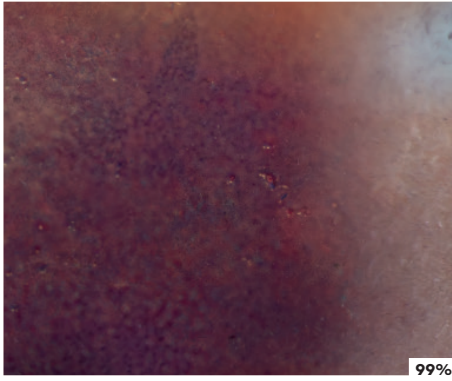
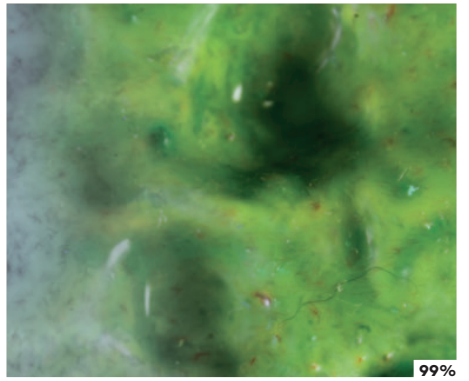
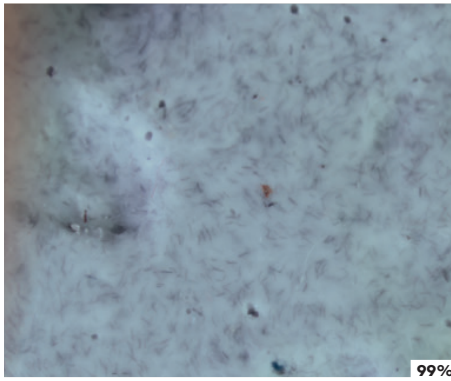
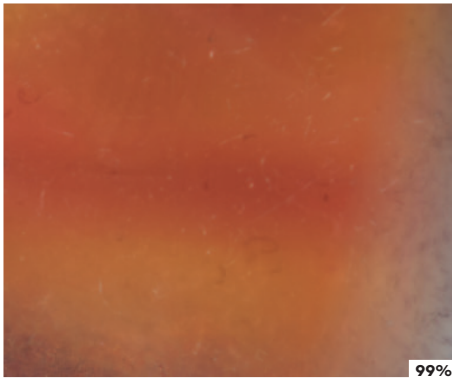
This zoomable disseminates research towards envisioning *soft biomorphism* as an alternative design paradigm for *soft robotics* (robots made from pliable and elastic materials). Earlier work on soft robotics has mainly been anchored in technical science and focused on improving the abilities of robots through mimicking the physiology and mechanical operations of soft natural organisms. Soft biomorphism seeks to enact a different perspective, to facilitate a reorientation of the field's interests.

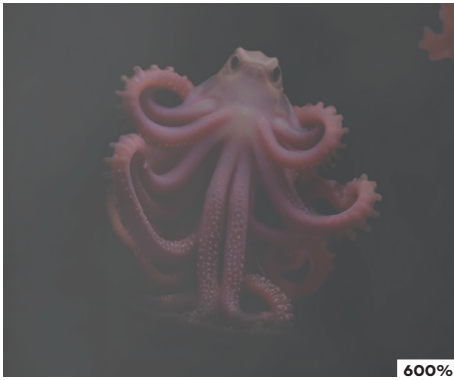
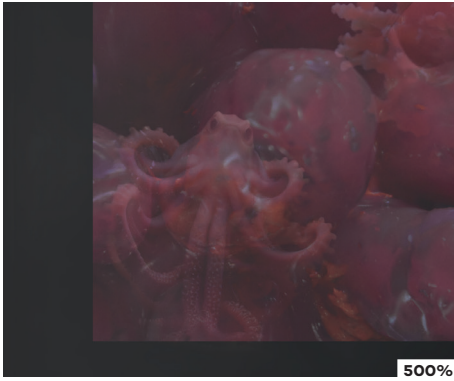
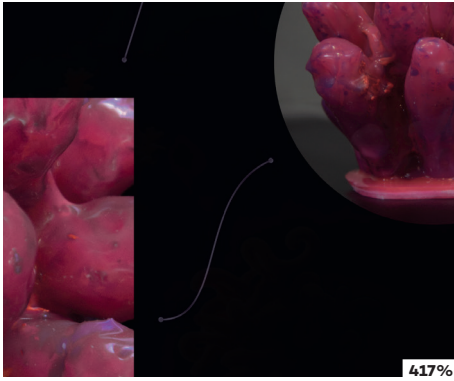
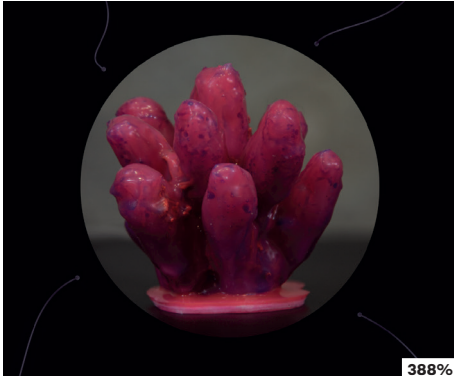
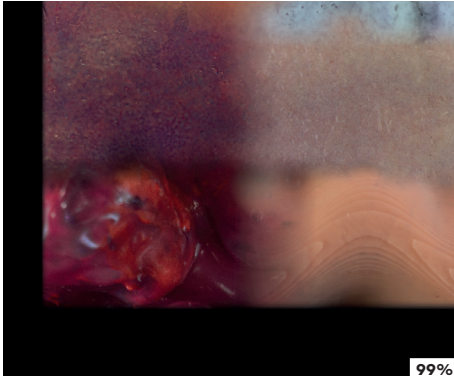
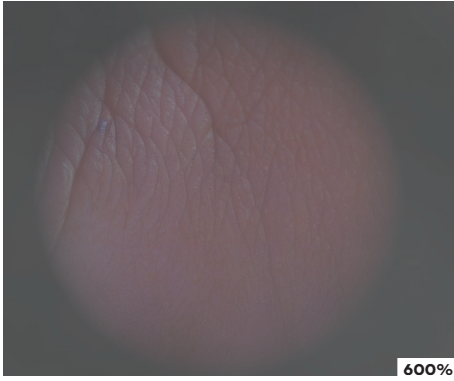
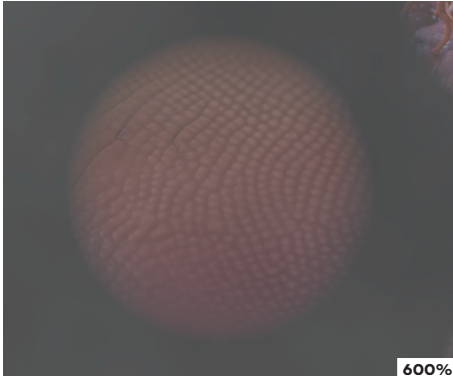
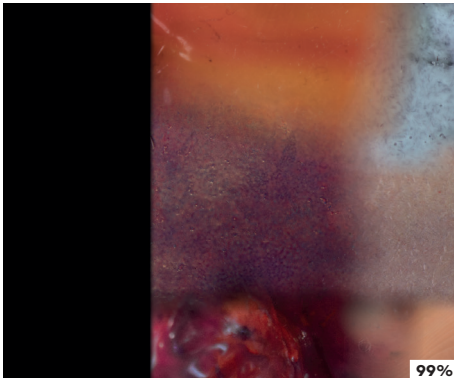
The notion of soft biomorphism is based on the simple premise of interrogating what happens when the inherently organic aesthetic of soft robots is emphasized and enhanced by incorporating inspiration from forms, colors, textures, and patterns of a biological origin. Soft biomorphism differs from other bioinspired design approaches used in robotics, as it eschews exact replication of a particular organism's morphological features, instead favoring select idiosyncratic or general visual and haptic similarities with natural organisms. Rather than seeking to deceive users into believing that a robot is alive, biomorphic elements are incorporated to cultivate connection and empathy between humans and machines. By appearing lifelike, yet unfamiliar, soft biomorphic robot designs could facilitate more open-ended, negotiable human–robot relations that are not modeled on human–human

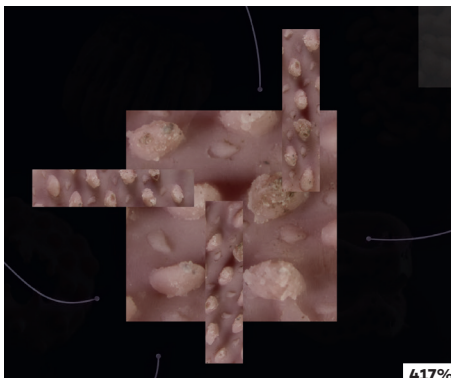
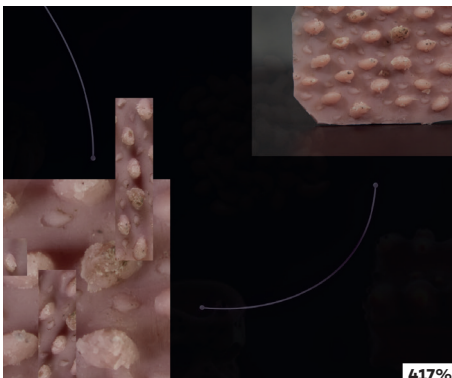
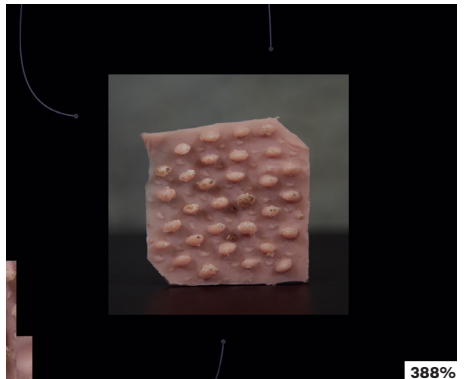
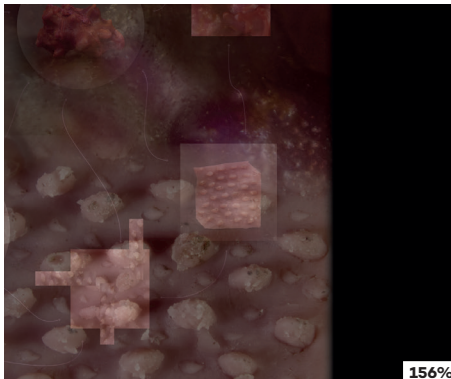
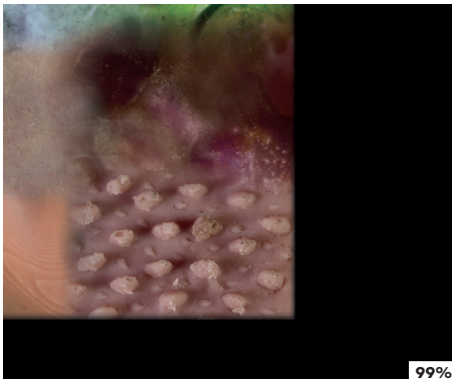
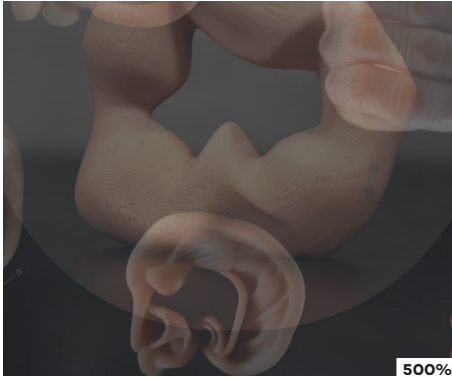
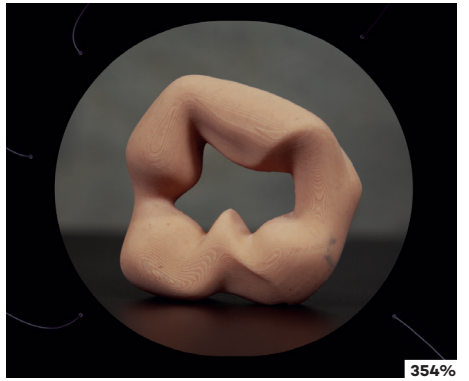
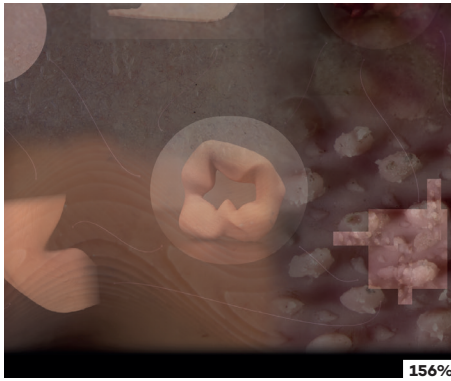
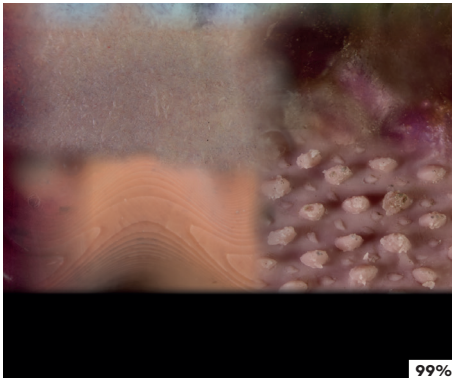
interaction or interactions with specific animals or domesticated pets. The artistic motivations underlying soft biomorphism also include critically reflecting on the boundaries between nature, technology, and their cultural uses and meanings.

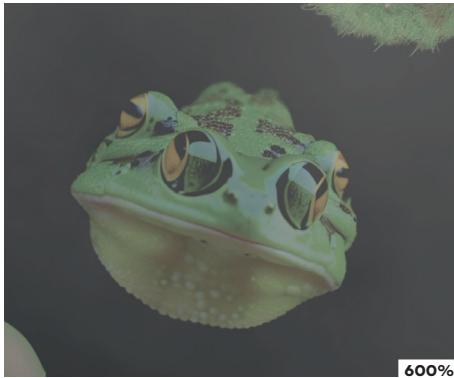
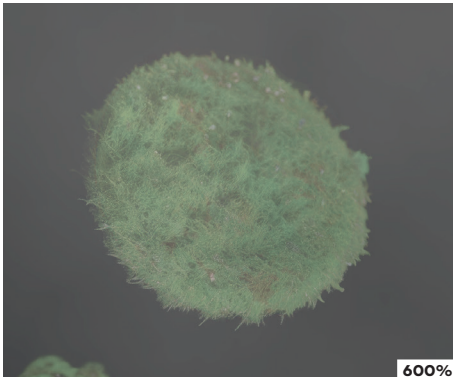
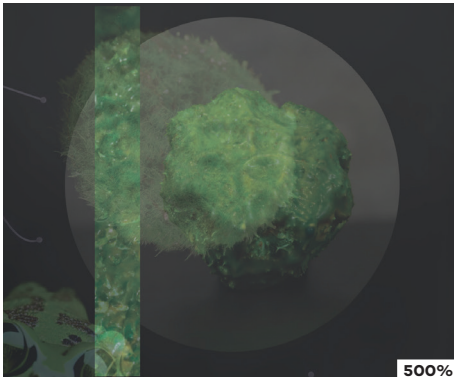
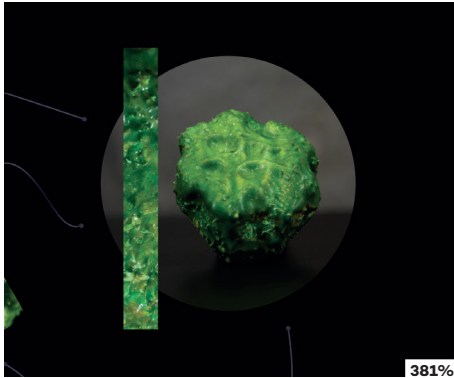
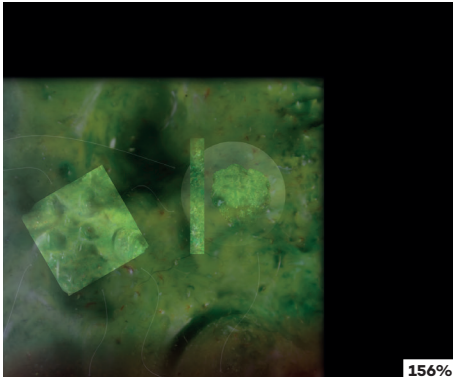
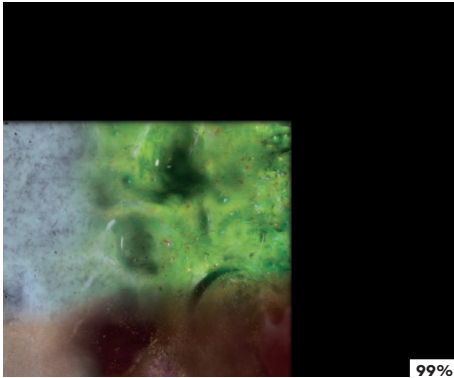
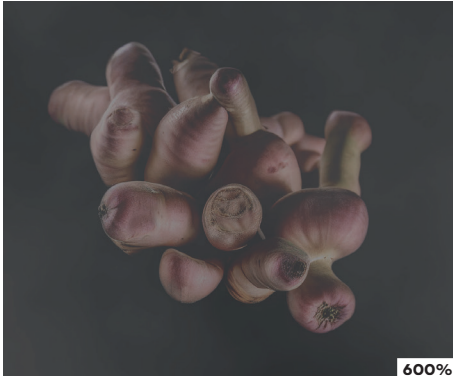
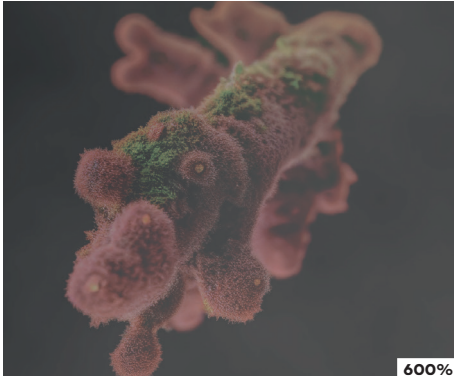
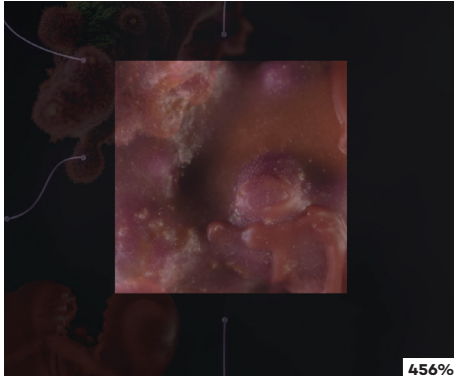
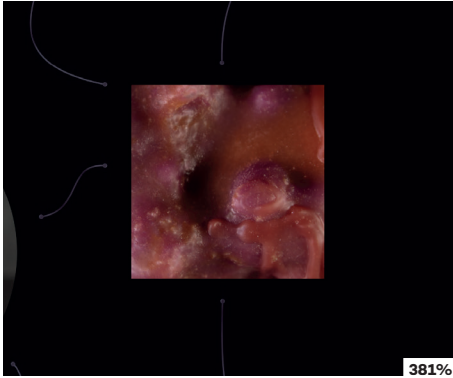
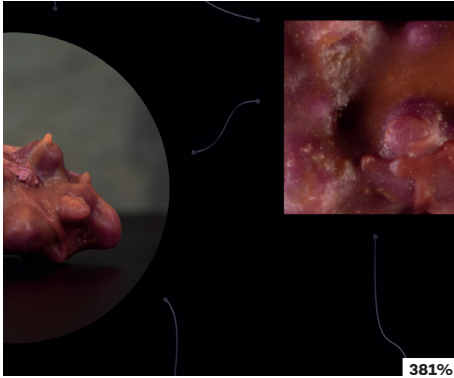
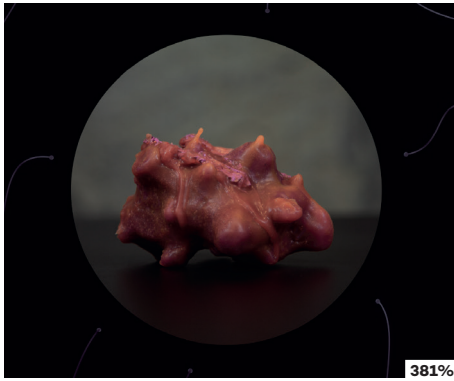
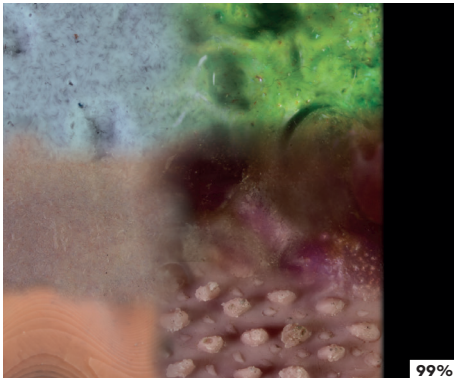
This practice-based work unites approaches from our diverse disciplinary backgrounds within soft robotics, mechanical engineering, human–robot interaction, artistic practice, and design research. We initially sought to unpack and enact soft biomorphism through the construction of a series of material prototypes and actuated behavioral objects. The interaction potentials of these soft biomorphic prototypes were subsequently interrogated in a physical human–robot interaction study (Christiansen *et al.*, 2023).

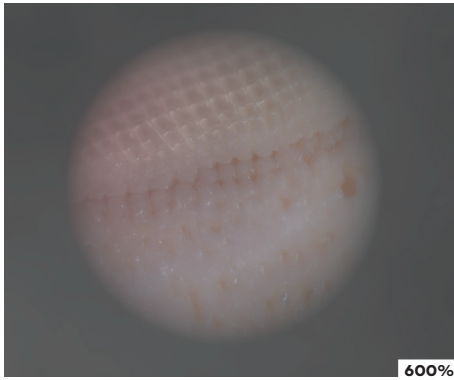
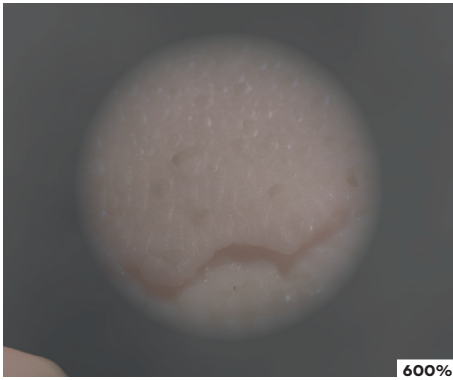
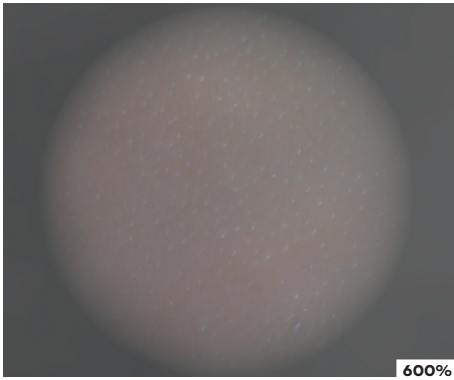
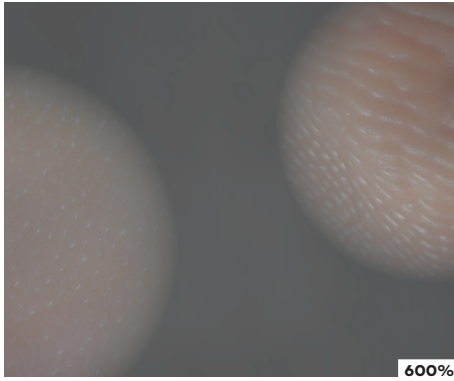
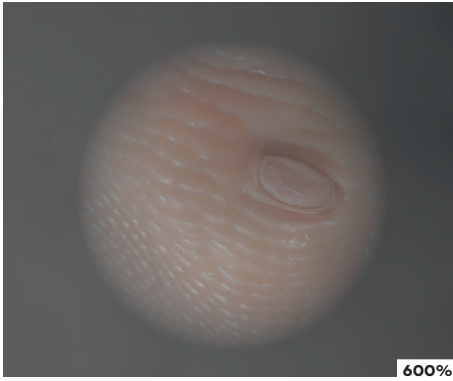
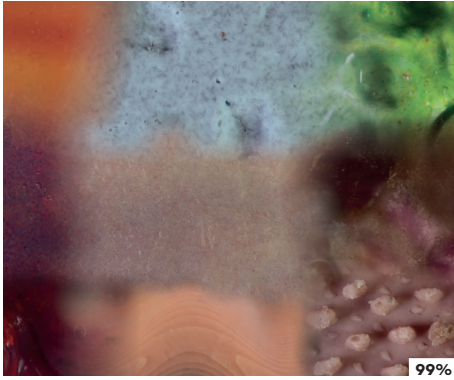
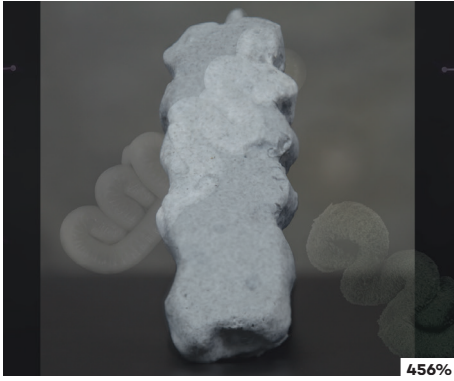
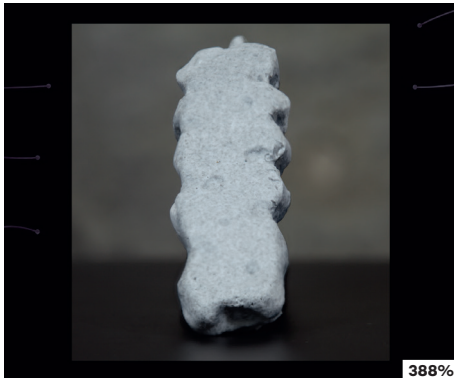
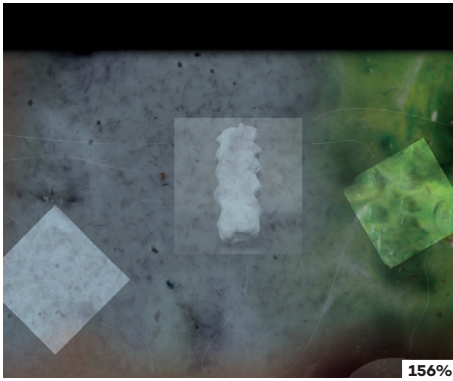
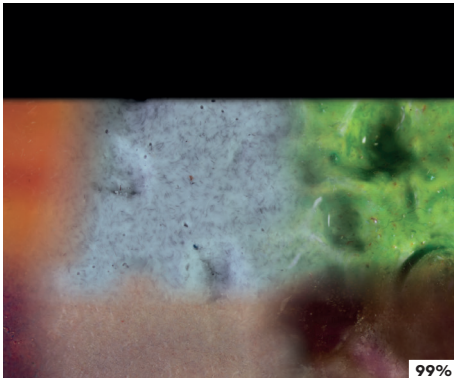
This zoomable focuses on articulating soft materiality and the biomorphological character of the prototypes as grounds for sensory perception, a potentiality of bodily sensations, and distinct types of embodied knowledge. While movement, sensing, and artificial cognition are integral to robotics technology and its aesthetics in general, our work investigates how soft materials themselves hold the potential to generate their own forms and relations when embedded in robotics. We further explore the aesthetics of soft biomorphic robots by employing photographs of our physical prototypes and text descriptions of their biomorphic inspirations as inputs for an AI image generation software. The resulting outputs, presented jointly on the final layer of the zoomable, suggest that connections in the web of life self-reflexively query the reification and remediation of biomorphic qualities within the virtual, latent space of global visual culture.







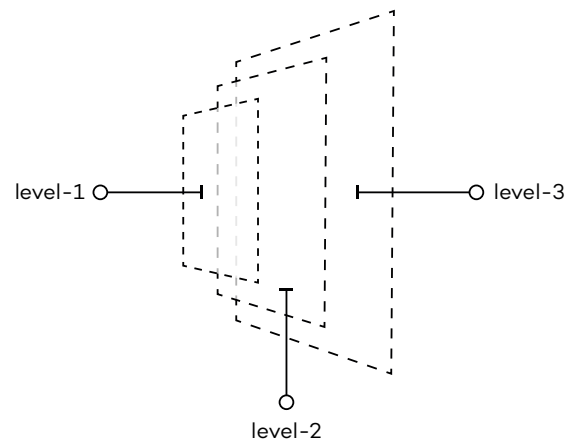




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The user can zoom in or out of the content by scrolling, and pan the image in any direction. By zooming in, successive layers appear.



credits

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photo editing: Oliver Heldmann, Mads Bering Christiansen

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Mads Bering Christiansen is a designer and a PhD student in the SDU Soft Robotics research lab, Biorobotics section, University of Southern Denmark, investigating the effects of integrating biomorphic aesthetics in soft robot designs for human–robot interaction.

Ahmad Rafsanjani (PhD) is a Professor in the SDU Soft Robotics research lab, Biorobotics section, University of Southern Denmark, working on integrating soft robotic materials and artificial intelligence for various applications, ranging from bioinspired locomotion to tactile perception.

Jonas Jørgensen (PhD) is an Associate Professor in the SDU Soft Robotics research lab, Biorobotics section, University of Southern Denmark. His work addresses issues related to artificial embodiment, soft materiality, and human–robot interaction and combines technical and natural science methods with humanities perspectives and practice-based art and design approaches.

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bibliography and references

BOOKS AND BOOK CHAPTERS

Botar, Oliver. 2016. "Biomorphism." In *Routledge Encyclopedia of Modernism* (1st ed.). London: Routledge. <https://doi.org/10.4324/9781135000356-REM770-1>

Botar, Oliver & Isabel Wünsche, eds. 2017. *Biocentrism and Modernism* (1st ed.). London: Routledge. <https://doi.org/10.4324/9781315096315>

McDonnell, Rachel, and Bilge Mutlu. 2021. "Appearance." In *The Handbook on Socially Interactive Agents: 20 years of Research on Embodied Conversational Agents, Intelligent Virtual Agents, and Social Robotics Volume 1: Methods, Behavior, Cognition* (1st ed), 105-146. New York: Association for Computing Machinery. <https://doi.org/10.1145/3477322.3477327>

Wilson, Edward O. 1984. *Biophilia*. Cambridge, MA: Harvard University Press.

JOURNAL ARTICLES

Budak, Ece Polen, Onur Zirhli, Adam A. Stokes, and Ozge Akbulut. 2016. "The Breathing Wall (BRALL)—Triggering Life (in)animate Surfaces." *Leonardo*, 49 (2): 162-163. https://doi.org/10.1162/LEON_a_01199

Christiansen, Mads B., Jonas Jørgensen, Anne-Sophie E. Belling, and Laura Beloff. 2020. "Soft Robotics and Posthuman Entities." *Journal for Artistic Research* 22. <https://doi.org/10.22501/jar.549014>

Christiansen, Mads B., Ahmad Rafsanjani, and Jonas Jørgensen. 2023. "'It Brings the Good Vibes': Exploring Biomorphic Aesthetics in the Design of Soft Personal Robots." *International Journal of Social Robotics*. <https://doi.org/10.1007/s12369-023-01037-6>

Jørgensen, Jonas. 2023. "Towards a Soft Science of Soft Robots: A Call for a Place for Aesthetics in Soft Robotics Research." *ACM Transactions on Human-Robot Interaction* 12 (2), 15: 1-15. <https://doi.org/10.1145/3533681>

Kovač, Mirko. 2014. "The Bioinspiration Design Paradigm: A Perspective for Soft Robotics." *Soft Robotics*, 1 (1): 28-37. <https://doi.org/10.1089/soro.2013.0004>

Sandry, Eleanor. 2015. Re-evaluating the Form and Communication of Social Robots. *International Journal of Social Robotics* 7 (3), 335-346. <https://doi.org/10.1007/s12369-014-0278-3>

CONFERENCE PAPERS

Boer, Laurens, and Harvey Bewley. 2018. "Reconfiguring the Appearance and Expression of Social Robots by Acknowledging their Otherness." *Proceedings of the 2018 Designing Interactive Systems Conference*, 667-677. <https://doi.org/10.1145/3196709.3196743>

Sabinson, Elena, Isha Pradhan, and Keith Evan Green. 2021. "Plant-Human Embodied Biofeedback (pheB): A Soft Robotic Surface for Emotion Regulation in Confined Physical Space." *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction*, 1-14. <https://doi.org/10.1145/3430524.3446065>

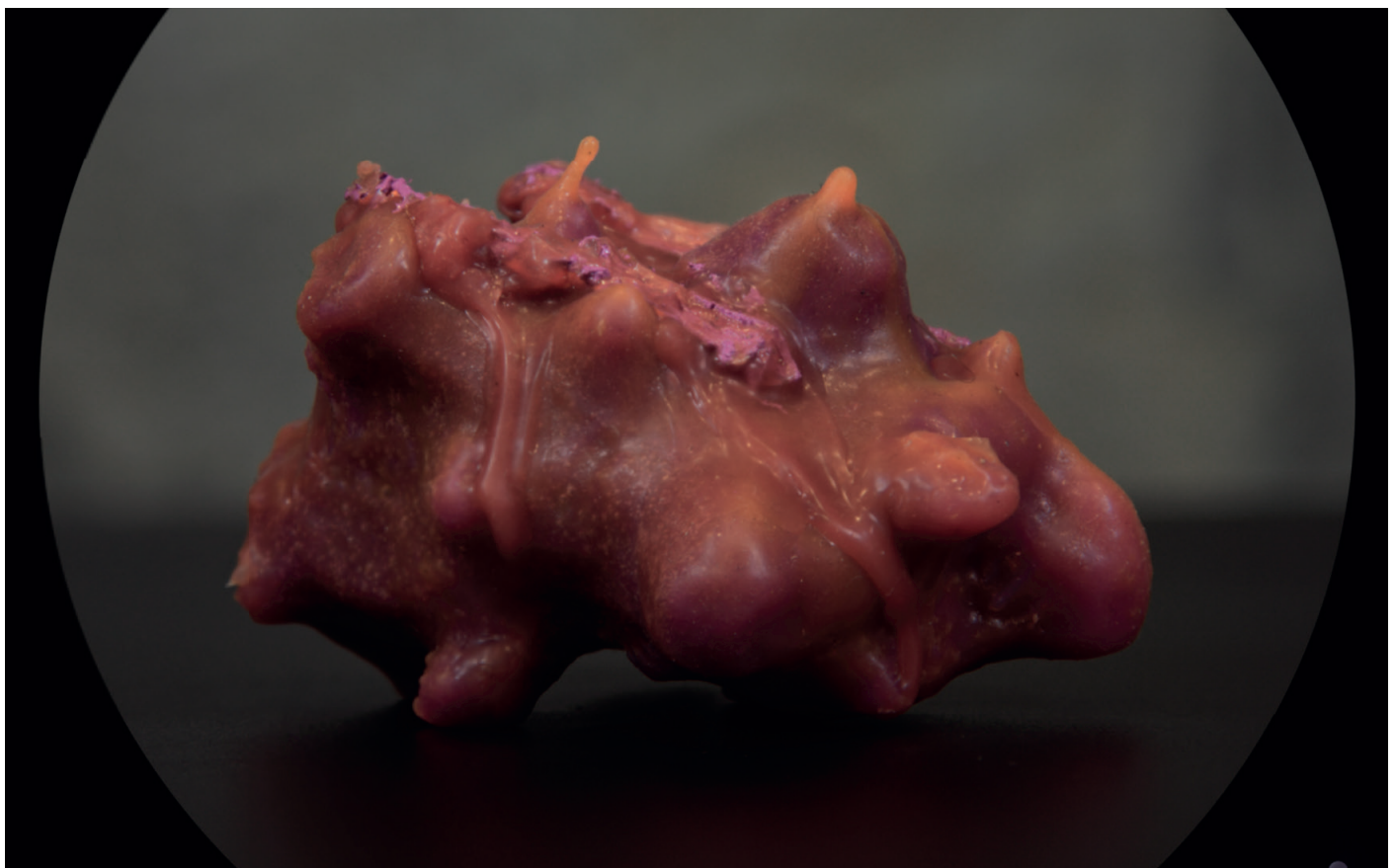
DOCTORAL DISSERTATIONS

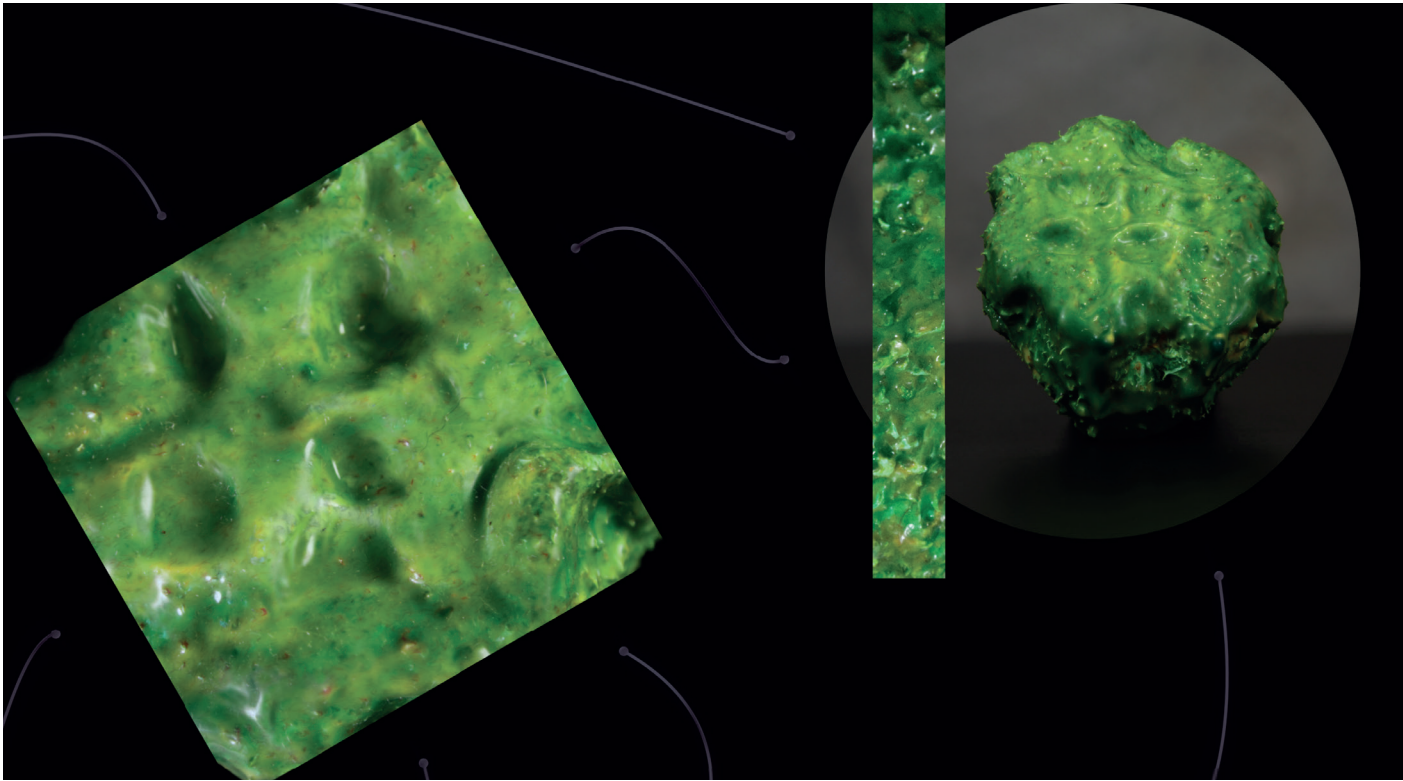
Jørgensen, Jonas. 2019. "Constructing Soft Robot Aesthetics: Art, Sensation, and Materiality in Practice." Doctoral dissertation, IT University of Copenhagen. <https://pure.itu.dk/da/publications/constructing-soft-robot-aesthetics-art-sensation-and-materiality->

Wihart, Michael. 2015. "The Architecture of Soft Machines." Doctoral dissertation, University College London. <https://discovery.ucl.ac.uk/id/eprint/1469447/>

EXHIBITION CATALOGUES

Steiermärkisches Landesmuseum Joanneum, Graz. 2008. *Leben?/Life?: Biomorphe Formen in der Skulptur/Biomorphic Forms in Sculpture*. Verlag der Buchhandlung.





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APA	EN	Christiansen, M. B., Rafsanjani, A., & Jørgensen, J. (2024). Ex Silico: Soft Biomorphs. <i>.able journal</i> . https://able-journal.org/en/ex-silico