# Expansion mini-microscopy: High quality magnification on the cheap

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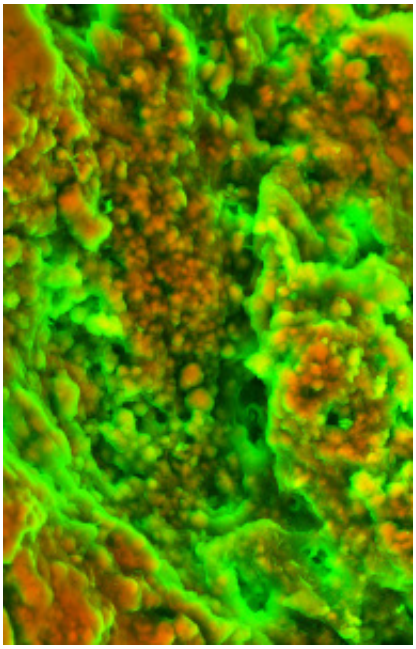

An image of a calcified human carotid artery atherosclerotic plaque using density-dependent color scanning electron microscopy (DDC-SEM)

Researchers from Brigham and Women's Hospital (BWH) and MIT have combined an innovative microscopy technique with a methodology for building inexpensive mini-microscopes, allowing them to capture images at a resolution that, until now, has only been possible with benchtop microscopes that are orders of magnitude higher in cost. Details about the hybrid technique, known as Expansion Mini-Microscopy (ExMM), are published this week in *Scientific Reports*.

The new work takes advantage of an expansion microscopy method recently developed by a group led by Edward Boyden, PhD, of the MIT Media Lab and McGovern Institute, and colleagues that uses a swellable gel to physically grow a specimen up to approximately 4.5 times its original dimensions. Bioengineers from BWH led by Ali Khademhosseini, PhD, director of the Biomaterials Innovation Research Center have recently built mini-microscopes from a webcam and off-the-shelf components, including fluorescence capacity with adjustable magnifications that cost as low as a few to a few tens of dollars per piece. However, the resolution of the images available using these mini-microscopes has been limited. Now, by integrating this approach with physical expansion of the samples, researchers have achieved a resolution comparable to the resolution previously attainable only by conventional benchtop microscopes.

As a proof of concept, the team put ExMM to the test by magnifying bacteria. They see wide-ranging applications for their technique, including use in developing countries for point-of-care diagnosis.

"We anticipate that our ExMM technology is likely to find widespread applications in low-cost, high-resolution imaging of biological and medical samples, potentially replacing the benchtop microscope in many cases where portability is a priority, such as in research and health care scenarios in undeveloped countries or remote places," said Khademhosseini.

"The beauty of the ExMM technology lies in its simplicity—by combining physical and optical magnifications, high performance is achievable at a low cost. It's a 'best of both worlds' technology, in a way, utilizing the best features of inexpensive chemicals and inexpensive optics," said Boyden.

"The further advancement of the technology, through the development

of cheap and simple ExMM detection kits and the algorithms associated with imaging processing, will allow streamlined sample preparation, imaging and analysis," said co-first author, Shrike Zhang, PhD, of BWH's Biomedical Division. Jae-Byum Chang, PhD, of the Boyden lab at MIT is also a co-first author of the study.

**More information:** Yu Shrike Zhang et al. Hybrid Microscopy: Enabling Inexpensive High-Performance Imaging through Combined Physical and Optical Magnifications, *Scientific Reports* (2016). DOI: 10.1038/srep22691

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