The use of MHz frequency surface acoustic waves for material exfoliation and manipulation

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While the remarkable properties of 2D crystalline materials offer tremendous opportunities for their use in a variety of fields including electronics, energy systems, and catalysis, their practical implementation largely depends critically on the ability to exfoliate them from a 3D bulk state. Although much progress has been made to date to address this bottleneck, this goal nevertheless remains elusive, particularly in terms of a rapid processing method that facilitates high yield and dimension control. In this talk, I will be presenting an ultrafast exfoliation approach that utilises the use 10 MHz order nanometre surface vibrations known as surface acoustic waves (SAWs) comprised of a combination of extraordinarily large mechanical acceleration (≈10^8 ms^{-2}) and electric field (≈10^7 Vm^{-1}) [1], which in turn is shown to efficiently exfoliate a range of materials including 2D MXenes sheets[2], MXene quantum dots[3], MoS_2[4], amongst others (Fig 1). Additionally, these powerful surface acoustic waves, when used at lower powers, can be used to tailor the electrical and physical properties of many material classes including metal transition dichalcogenides (TMDs)[5] and metal organic frameworks (MOFs)[6].

References

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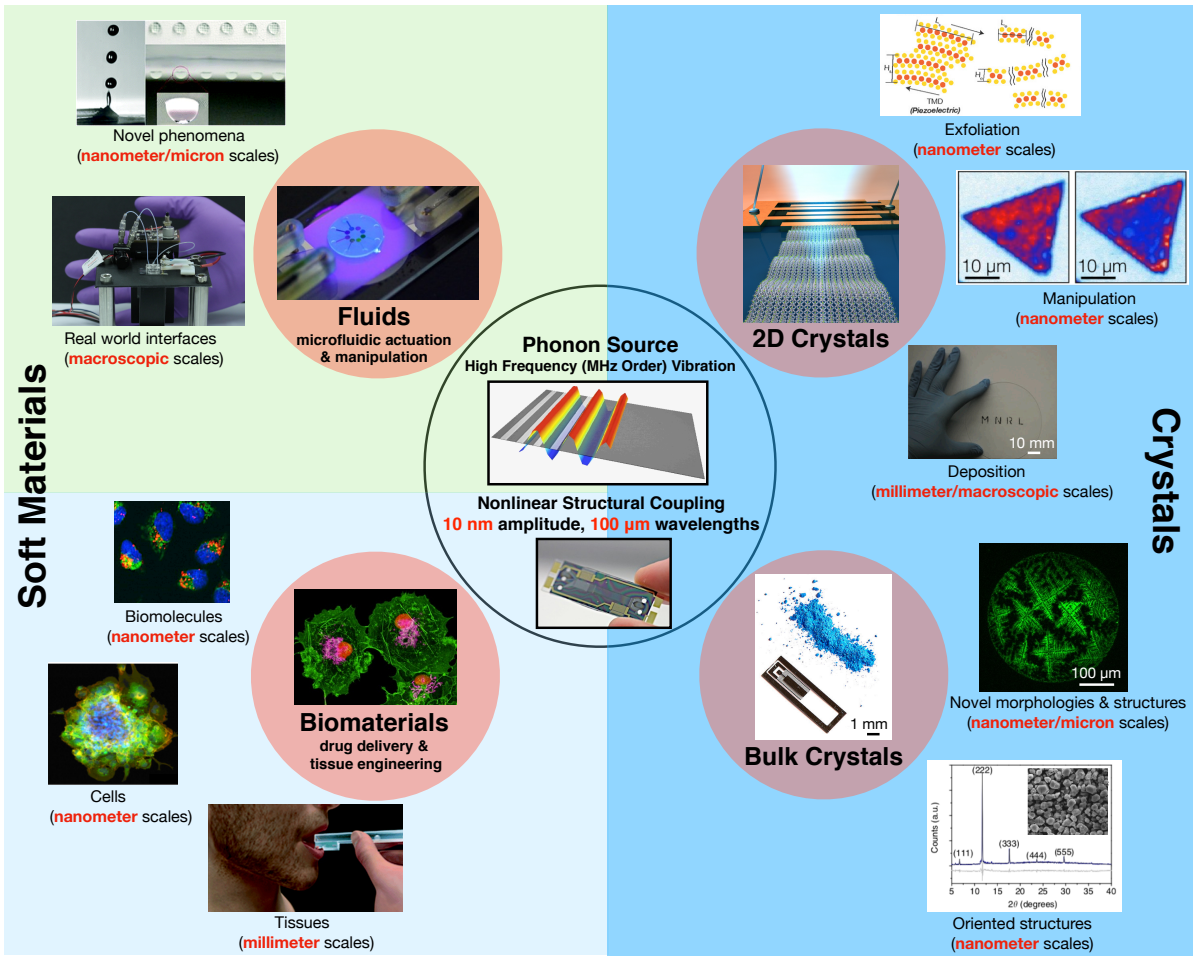

Figure 1: Examples demonstrating the use of 10 MHz order surface acoustic waves for crystals manipulation, including 3D, 2D, 1D and OD. From reference [1]