

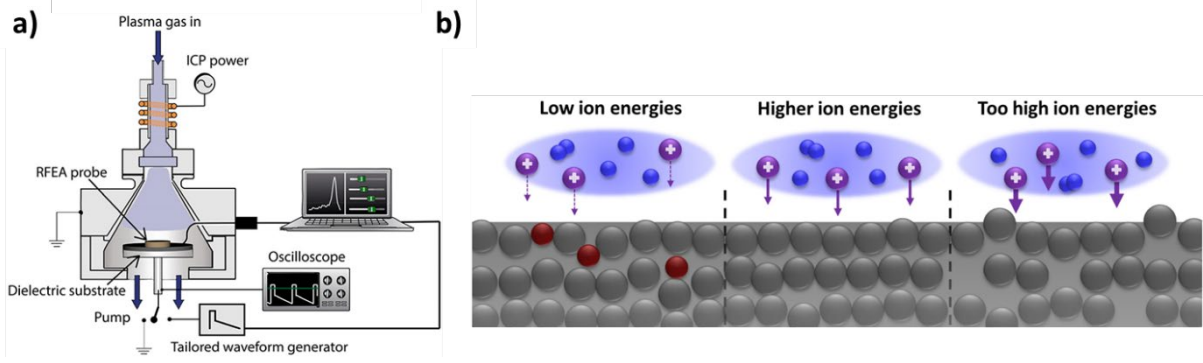


Figure 1 **a)** Schematic of the experimental setup showing the Oxford Instruments FlexAL reactor with an RFEA probe on a dielectric substrate. The substrate table can switch between ground and the TW generator. **b)** Schematic depiction of impurity removal and densification through energetic ion bombardment, and damage induced by too high ion energies.

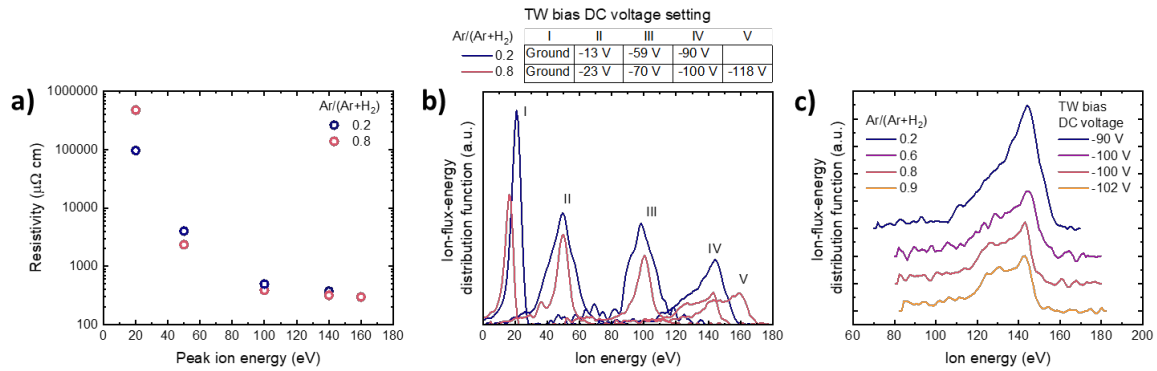


Figure 2 **a)** Room-temperature electrical resistivities of ~ 7 nm $\text{TaC}_x\text{N}_{1-x}$ films prepared using plasma with various peak ion energies for two different Ar- H_2 gas mixtures supplied to the plasma. **b)** Corresponding ion-energy-flux distribution functions as measured by retarding field energy analyzer using various tailored-waveform (TW) bias DC voltages. **c)** Ion-energy-flux distributions for different Ar- H_2 gas mixtures supplied to the plasma using similar TW bias DC voltages.

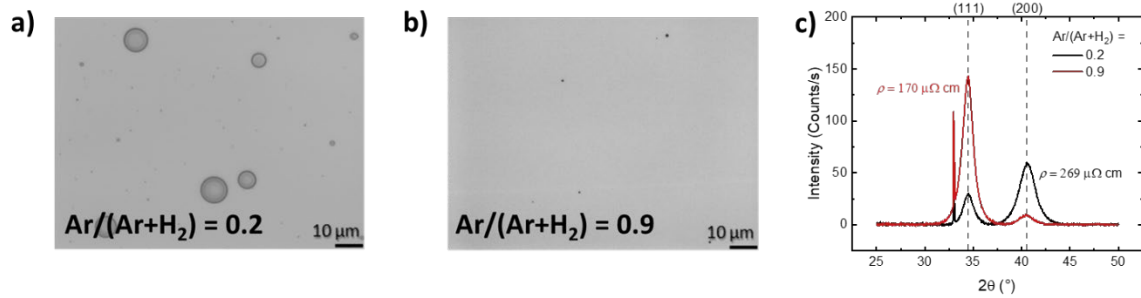


Figure 3 **a)** Large blisters observed in a 32 nm $\text{TaC}_x\text{N}_{1-x}$ film prepared with an Ar- $\text{H}_2=10-40$ sccm gas mixture supplied to the plasma. **b)** Small blisters observed in a 32 nm $\text{TaC}_x\text{N}_{1-x}$ film prepared with an Ar- $\text{H}_2=45-5$ sccm gas mixture. **c)** Gonio X-ray diffraction measurements of the two films labelled with their room-temperature resistivities.