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IT-17-P-3236 Improving Yield and Data Quality in Atom Probe Tomography

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The electric fields used in atom probe tomography (APT) generate stresses normal to the specimen axis proportional to the electric field squared [1]. As such, specimen fracture has long been a serious problem for APT [2-3]. There are many methods to improve yield, often with a trade-off required in experimental quality or convenience in some other area. Methods to improve yield include: 1) decrease ion detection rate, 2) increase specimen temperature, 3) use laser pulsing, 4) increase laser pulse energy, 5) increase background chamber pressure, 6) change feature orientation [4], 7) coat a sharpened specimen with a thin layer of material [3,6], and 8) slightly anneal the specimen. Figure 1 schematically illustrates several of these methods to improve APT specimen yield. The current work explores the use of thin coatings to modify the thermal and/or optical properties of 302 stainless steel and a Si/SiO2(10nm)/Si/Ni test structure in attempts to improve yield.

Although method number 3+4 above works well to improve yield, substantial increases in laser energy are often limited in materials with poor thermal diffusivity due to a degradation in data quality (e.g., long “thermal tails” in the mass spectrum, non-uniform detector hit-maps, etc.) [7,8]. An example of this effect is shown in the non-uniform detector hitmaps in a poor thermal diffusivity material (302 stainless steel). Figure 2 shows the effects of increasing laser pulse energy and suggests an increasing trend in azimuthal asymmetry (note laser incidence is lower left). Figure 3 presents the mass resolving power (MRP) at tenth maximum, uniformity in the form of XY hitmap signal correlation (lower values are desirable) [6], and spectral background as a function of laser energy.

In order to investigate the yield improvement of coatings, we have developed a test structure of uncoated Si/SiO2(10nm)/Si/Ni on which we can reach data collection conditions where this sample both does and does not yield. These data have been reproduced by successful data collection from the entire structure multiple times. Statistically, yield changes are difficult to prove unequivocally; however we have good evidence for an improvement for this oxide-based structure with thin metal coatings in Figure 4.

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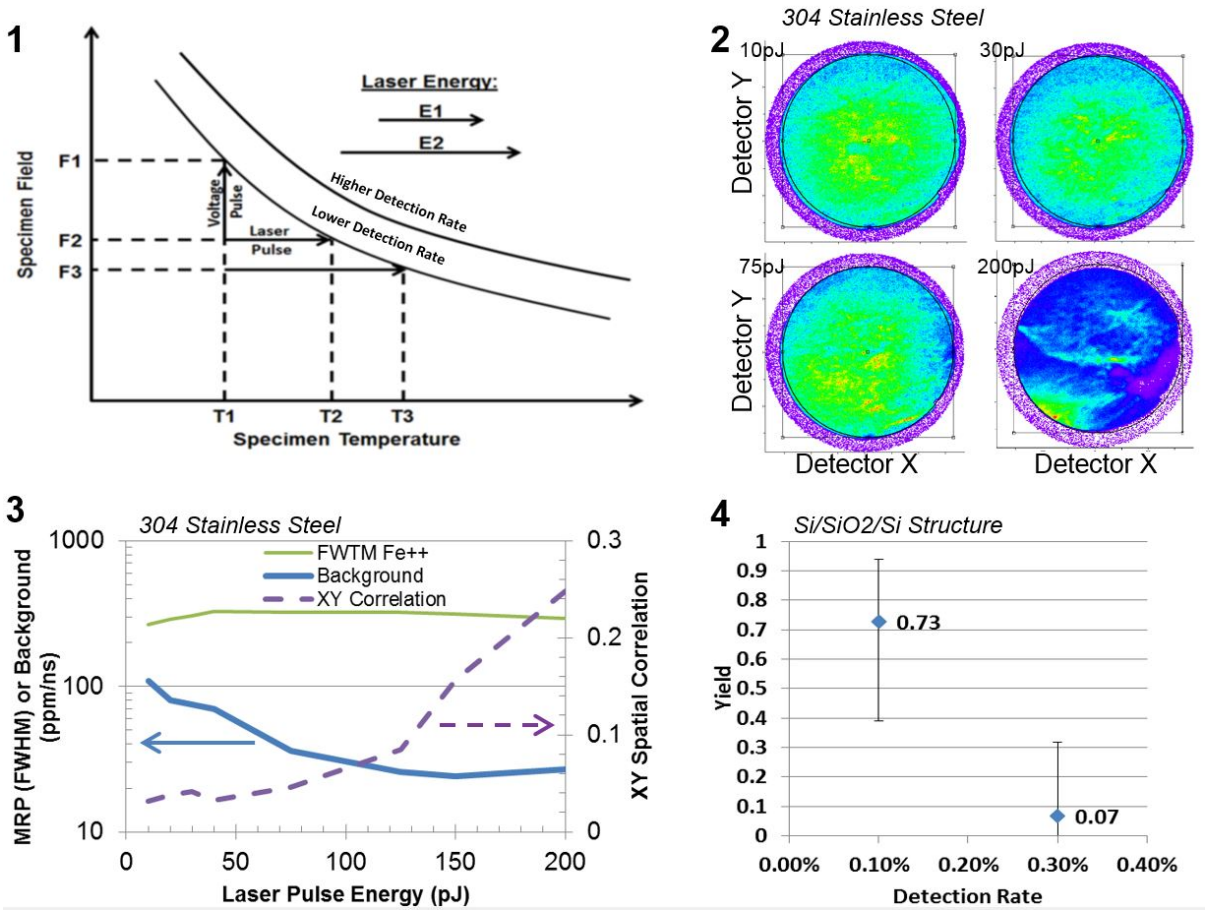

Fig. 1: 1)Methods to improve APT yield. 2)Effects of increasing laser pulse energy suggesting a trend in azimuthal asymmetry laser incidence is LL). 3)Mass resolving power at tenth maximum, uniformity in the form of XY hitmap signal correlation (lower=better). 4)Yield differences on a difficult to run specimen as a funciton of detection rate and coating.