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Recipe for coating ceramic blades for ion trapping

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Recipe for coating ceramic blades for ion trapping

Standard Recipe (All parts & fixtures)

1. Vapor Degrease
2. Acetone Rinse
3. IPA Rinse
4. Dry with filtered N2 followed by IR heat lamp.
5. Air Fire (10 C/min up to 860 ^{o}C, 860C for 1 hour, 10 C/min down to RT).
6. Evaporation (Patterned Parts)
    a. Plasma Ash in Fixture (O_2 250 mTorr, 100 W, 5 min)
    b. We laser machined ceramic shadow masks to define the evaporation region on the traps and prevent shorting between electrodes, and held the traps + shadow masks in a fixture.
    c. We sputtered from 2 directions to cover the sidewalls.
    d. Target Thickness: 1000 Å Ti / 10,000 Å Au on both sides.
7. Sputter (Blanket Coated Parts)
    a. Pre-Sputter Etch (50 W, 2 min, before loading parts, chamber would be pre-coated with thin Ti layer else pre-sputter etch may contaminate parts).
    b. We laser machined ceramic holders to create a fixture that would hold multiple ceramic trap substrates.
    c. We sputtered from 2 directions to cover the sidewalls.
    d. Target Thickness: 1000 Å Ti / 10,000 Å Au
8. Inspection
    a. Metallization will accentuate the surface finish. Some of the parts may have a matte appearance as opposed to appearing shiny. If metallization appears blotchy, the parts may have been handled without glove, the surface finish may be inconsistent, or you may have a contamination issue and should check adhesion with a tape test.
9. Double seal in nylon bags and deliver.

Extreme Recipe

1. Parts Preparation
    a. HF Rinse (supplied 50%, diluted to 7% for 10 min at room temperature)
    b. DI Rinse
    c. Boiling H_2O_2 bath (103 ^{o}C for 5 min)
    d. DI Rinse
    e. Blow dry with filtered N_2 dry followed by IR heat lamp.
2. Fixture Preparation
    a. Vapor Degreaser
    b. Acetone Rinse
    c. IPA Rinse
    d. Dry filtered N2
    e. Blow dry with filtered N_2 dry followed by IR heat lamp.
3. Evaporation (Patterned Parts)
    a. Plasma Ash in Fixture (O_2 250 mTorr, 100 W, 5 min)
    b. Target Thickness: 1000 Å Ti / 10,000 Å Au on both sides.
4. Sputter (Blanket Coated Parts)

    a. Pre-Sputter Etch (50 W, 2 min, before loading parts, chamber would be pre-coated with thin Ti layer else pre-sputter etch may contaminate parts)
    b. Target Thickness: 1000 Å Ti / 10,000 Å Au
5. Inspection
    a. Metallization will accentuate the surface finish. Some of the parts may have a matte appearance as opposed to appearing shiny. If metallization appears blotchy, the parts may have been handled without glove, the surface finish may be inconsistent, or you may have a contamination issue and should check adhesion with a tape test.
6. Double seal in nylon bags and deliver.

Additional comments

The first batches of ion traps patterned and coated were processed per the standard 3-step clean, air fire, and metallization processes. The third or fourth lot using this process resulted in poorly adhering metallization. Up until this point, the standard process was used to metallize and pattern ceramic ion traps without fail. At about the 4^{th} batch of parts something changed.

After the 5^{th} batch, the ceramic ion traps received generally came with some unknown contamination that does not come off in a standard 3-step clean (Lenium Vapor Degreaser, Acetone, IPA) and air fire (860C for 1 hour) for which this process removes the vast majority of all contamination for most ceramic metallization. This is highly unusual. Using HF + Boiling H_20_2 is extreme for cleaning the ceramic ion traps. The contamination was never identified and is stubborn to effectively clean. Standard as-fired ceramic should be very easy to clean as it's fired at temperatures greater than 1400°C and not much in terms of contamination should exist at these temperatures, so there must be an intermediate step/process which is imparting this contamination. It is likely a polishing compound or previous polishing contaminant, but also not easily visually distinguishable until after metallization. The halo marks observed on parts might be fingerprints (less likely) or potential polishing marks (more likely) as metallization typically doesn't cover/hide any damage or contamination, but rather quite clearly the opposite, it accentuates it. Blotchy appearances in the metallization usually indicated an adhesion issue.

As a result of the fragility of the parts (yield loss due to handling) and difficulty in identifying the contamination during cleaning, we have taken a conservative approach of HF + H_2O_2 cleaning for all batches after the contamination and adhesion issues were identified.