LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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LMA coating on ITM04 and ITM08

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LIGO Science Collaboration

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1. Introduction

The effect of the coating uniformity by LMA on ITM04 and ITM08 is studied.

The coating is good enough for ITM, but the uniformity on ETM based on the uniformity on ITM is not acceptable as was predicted by previous analyses (T1100111, T1200062, T1200137).

2. Analysis

The phasemaps of ITM04 and ITM08 were measured at Caltech after they were coated by LMA. While the ITM08 map was measured after all processes, the ITM04 map was measured before the AR coating and without annealing and the curvature will change some by these processes.

The purpose of this analysis is the estimation of the general quality of the coating uniformity and the variation from coating to coating. In order to avoid the aforementioned uncertainty, the power term was removed from maps analyzed. The result is essentially identical if astigmatic term is removed or not.

The centering of the map data may have small uncertainties. But main results are unaffected by shifting the center of the mirror by a few mm.

3. Comparison of maps

Fig.1 compares the cross sections of maps, before and after coating. The center of the plateau is off by a few mm (this may be a systematic error of the measurement) and the size of the plateau is 2% narrower for ITM08 than that of ITM04.

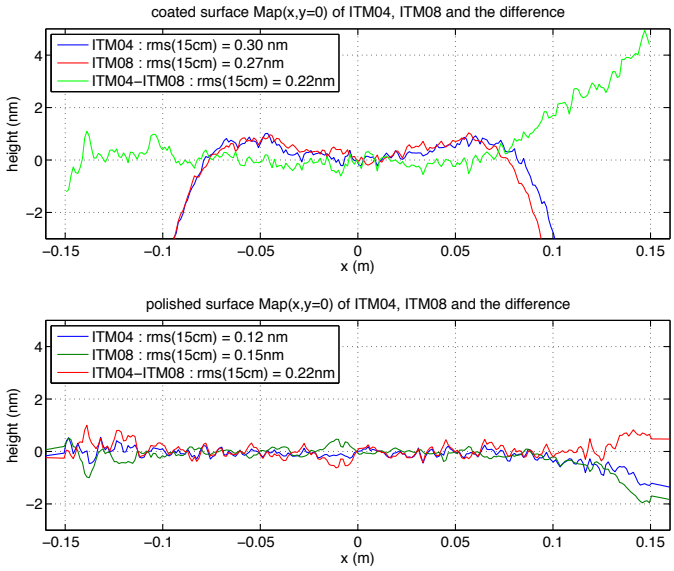

Figure 1 ITM maps, before and after coating

The RMS values in the plot show rms calculated along a line in the central region, x=-7.5cm to 7.5cm, y=0.

Fig.2 is the 2D plot of ITM04-ITM08 maps after coating.

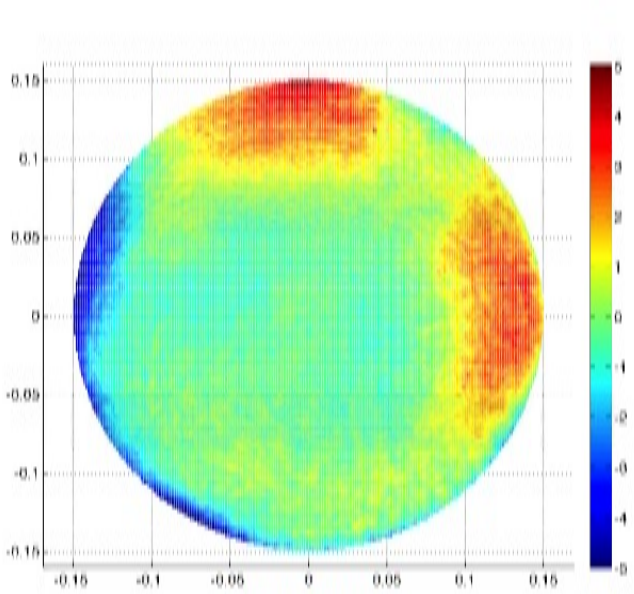

Figure 2 Difference of maps : ITM04-ITM08

Fig.3 is the comparison of PSDs. The PSD degrades in the long wavelength region by the coating, and some degradation is observed in the short wavelength region, < 1cm, as well.

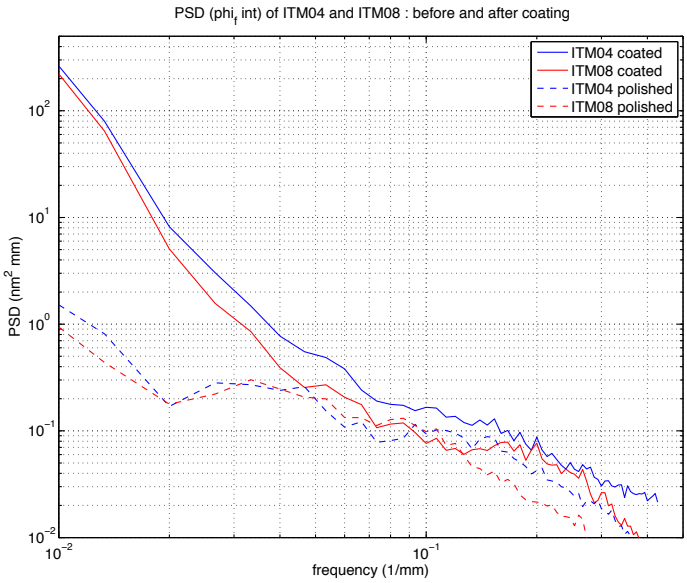

Figure 3 Comparison of PSD

4. Effects on the FP performance

Placing these ITM maps in a aLIGO cavity (ROC(ITM)=1934m, ROC(ETM)=2245m, Lcav=3994.5m, T(ITM)=1.4%), the effects of these 4 phasemaps were calculated. In the following table, round trip loss and mode contents are compared for 4 cases, ITM04 and ITM08, before and after coating. The curvature and tilt components are removed before the calculation, there is no TEM01, TEM10, nor LG_{10} modes in the cavity.

		Round trip loss (ppm)	Non 00 mode in cavity (ppm)	LG20 mode in cavity (ppm)
polished	ITM04	2.9	3.2	0
	ITM08	3.0	3.5	0
coated	ITM04	2.7	8.8	2.8
	ITM08	3.0	9.0	4.9

Table 1 Cavity quality factors

The diffractive loss is not changed by the coating, but the mode content of the resonating field is. Among modes of LG_{pm}, with 2p+m<=10, only LG_{20} mode is sizable in the cavity field. The plateau structure on the coated surface induces this mode.

5. conclusion

The field quality of this size is fully acceptable for ITM, but, if the ETM quality is estimated by scaling the ITM variation, the ETM quality may not be acceptable as was discussed in previous analyses. Also it was found that the plateau size changes by a few %, and this can induce non negligible contrast defect.