Cannelli, Cantelli, and Cordero Reply: In our previous work [1] we have analyzed the acoustic emission (AE) resulting from the cracking during the hydride precipitation in Nb samples, and found that the amplitude distribution function of the events follows a power law. Since the absence of an intrinsic scale of the stress wave amplitudes cannot be ascribed to the morphologies of the metal grains or the precipitate particles, which are rather regular [2], we interpreted it as the signature of a self-organized critical (SOC) state.

Sornette [3] claims that the power-law distribution of the AE events results from a mechanism different from the self-organized criticality. The criticism is based on three arguments: (i) a presumed fine tuning implicit in the slow cooling of the metal hydrogen system; (ii) the assertion that AE cannot be sustained forever because it stops when the α-β transformation is completed; and (iii) the fact that damage accumulates irreversibly.

Regarding the first objection, we do not think that cooling at a constant rate is equivalent to tuning a parameter which directly controls the SOC state. In fact, we have shown that the same power law was observed at two different cooling rates (1 and 4 K/min); acoustic emission would have been stimulated also by simply cooling the sample at any cooling rate to any temperature below the transformation temperatures T_t. On cooling, the metal-hydrogen system evolves to a state in which the increasing local stresses at the precipitate interfaces are continuously released by the pileup of dislocations and the consequent crack nucleation [4]. The H precipitation supplies the driving force at the α-β interfaces, which increases at a rate governed by the slow kinetics of the transformation [2]; the stress released by crack formation and propagation gives rise to acoustic waves with amplitudes distributed according to a power law. Therefore, once the temperature has been lowered below T_t, the system puts itself automatically to the SOC state, without any external fine tuning.

The remark that the AE stops when the α-β transformation is completed is not an argument against our interpretation. In fact, the system may well be in a SOC state while precipitation is occurring, exactly like a sand pile is in the stationary SOC state only while continuously fed with new grains. In addition, the H atoms from solid solution can continuously feed the growth of the precipitates for a very long time, since several days may be required to reach the thermodynamic equilibrium between the two phases [5].

The criticism based on the occurrence of irreversible damage would be valid if we interpreted our experiment as a perfect realization of a SOC state. This objection is related to the previous one, and, again, we do not agree with the requirement that a system must remain perpetually stationary in order to be considered in a SOC state. We argue that the building up and releasing of the stresses in our samples during H precipitation and cracking may constitute a SOC state during a time interval in which the damage is not excessive. The same restriction is implicit in the interpretation by Chen, Bak, and Obukhov [6] of the experiment of stressed Al and Nb rods; the only difference between the two experiments consists in the fact that in the latter one the fracture events are induced by the application of an external stress.

The occurrence of accumulation and release of stresses during the fracture phenomena induced Chen, Bak, and Obukhov [6] to propose a crack-propagation model of earthquakes. According to them, the fracture mechanism replicates the dynamics of earthquakes due to tectonic plates of the Earth's crust which slide against other plates creating faults; in this way the local stress is released and propagates to adjacent regions. Alternatively, Sornette proposes a "democratic fiber bundle model" to simulate cracking. Although we cannot discard in principle models other than SOC, to explain the power-law distribution of the event amplitudes, we observe that our experiment presents much closer analogies with the crack propagation model of earthquakes than with the "democratic fiber bundle model."

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